CONTRACT DOCUMENTS

FOR THE CONSTRUCTION OF

JSSD OLD HIGHWAY 40 PUMP STATION AND TREATMENT PROJECT

(FISHER RANCH WTP PROJECT)

Volume 1 OF 1
Specifications

JORDANELLE SPECIAL SERVICE DISTRICT

Jordanelle Special Service District

For Information Regarding this Project Contact:
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Draper, Utah 84020
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BOWEN COLLINS & ASSOCIATES

December 2021

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JSSD OLD HWY 40 PUMP STATION AND TREATMENT PROJECT (FISHER RANCH WATER TREATMENT PLANT)

CONSULTANT PROJECT NO.: 056-20-01

December 15, 2021

OWNER
Jordanelle Special Service District

ENGINEER

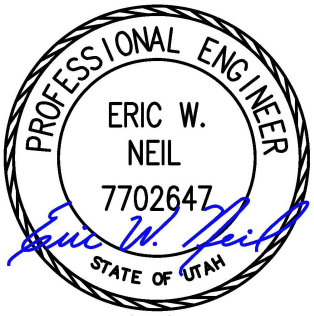
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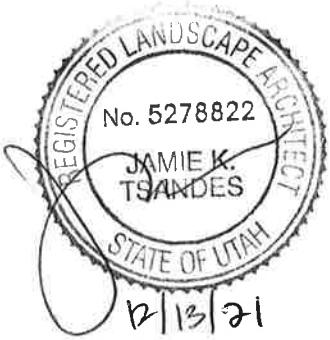


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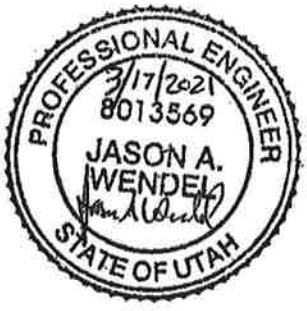
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[HVAC]



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APPENDIX

APPENDIX A – STAGING MAPS

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INVITATION TO BID

RECEIPT OF BIDS: Sealed Bids will be received at the office of Jordanelle Special Services District (JSSD), Owner of the Work, located at 5360 North Old Hwy 40, Heber City, Utah 84032 until 2:00pm, on February 1, 2022, for construction of the JSSD Old Hwy 40 Pump Station and Treatment Project (Fisher Ranch Water Treatment Plant). Any Bids received after the specified time will not be considered.

OBTAINING CONTRACT DOCUMENTS: The Contract Documents are entitled JSSD Old Hwy 40 Pump Station and Treatment Project (Fisher Ranch Water Treatment Plant), referred as FRWTP. The digital Contract Documents will be provided to each pre-qualified Contractor on December 15, 2021, in portable document format (PDF) at no cost. Printed copies of the Contractor Documents can be provided upon payment of $150 (non-refundable) and one weeks advanced notice to the Engineer. The scale of the reduced drawings is about one-half of the original scale. If full-scale drawings are desired, they may be purchased at reproduction cost (not refundable) from the Engineer. Hardcopy Contract Documents are available at the office of the Engineer for review and are also available at various plan rooms.

PROJECT OVERVIEW: The project consists of construction of a new surface water treatment plant to treat water from the Provo River for use within the JSSD culinary distribution system. The Project also includes finished water pumping facilities and a 10,000 gpm raw water snowmaking pumping system.

DESCRIPTION OF WORK: The Work of the Contractor comprises construction of a new 24,700 square-foot water treatment plant and pumping facility. The Work generally includes the construction/installation of the following:

1. Construction of a new 4 million gallon per day (mgd) water treatment facility, with anticipated ultimate capacity of 8 mgd
2. The 24,700 square foot building includes the following areas and features:
    a. Main level garage area above the clearwell
    b. Cast in place concrete finished water basement clearwell area below the finished water pump and garage areas
    c. Finished water pump station area with three vertical turbine pumps (with space for two future pumps) and associated surge tank, valves, mechanical piping, flow meter, and electrical.
    d. Snowmaking pump station area with six vertical turbine “canned” pumps and associated surge tank, basket strainer, valves, mechanical piping, flow meter, and electrical
    e. Electrical room and plant power system (with backup diesel generators) and miscellaneous lighting and power systems
    f. Mezzanine finished office space areas, SCADA/controls room, kitchen, and laboratory
    g. Miscellaneous building mechanical systems, HVAC, utilities, security, and piping
    h. CMU building with architectural finishes

3. Installation of Owner purchased/supplied water treatment package system (4 mgd total): Four (4) 1 mgd treatment trains, each including valves, flow meters, instrumentation, and walkways. The system generally includes air blowers, flash mixer, backwash control valve, PLC controls, and ancillary equipment and instrumentation. The Owner supplied treatment package system submittal is included with these bid documents.
4. Treatment chemical feed systems in separate containment areas that include:
    a. Caustic Soda feed system with bulk storage and metering pump systems
    b. Primary Coagulant feed system with bulk storage and metering pump systems
    c. Flocculant Aid Polymer storage, blending, and feed system with storage and metering pumps
    d. Installation of new on-site sodium hypochlorite (chlorine) system including on-site generators, power, salt/brine storage system, storage tank, and metering pump systems
    e. Chemical controls systems and instrumentation integrated in the plant controls
5. Sludge drying beds (cast in place concrete 100' x 150') with associated access roads, yard piping, valves, and decant pumping system.
6. Plant under-slab piping for treatment equipment piping connections
7. Plant raw water inlet piping system with basket strainers
8. Plant backwash system with PRVs and pressure relief valves and piping.
9. Civil work including raising and leveling the site, new access roads and asphalt parking area, fencing and site security, and general yard piping, site utilities, and drainage.
10. SCADA hardware and integration by Owner's selected Integrator.

SITE OF WORK: JSSD Old Hwy 40 Pump Station and Treatment Project (Fisher Ranch Water Treatment Plant) Site, north of Heber, Utah on Old Highway 40 at the following approximate location:

Address: 6556 N Old Highway 40, Wasatch County, UT
Lat: 40°35'42.99"N
Long: 111°25'29.55"W
Elevation: 5,882 ft msl

PRE-BID MEETING: Mandatory pre-bid meeting January 5, 2022, 10:00 am at the office of the Engineer, 154 East 15074 South, Draper, UT 84020.

COMPLETION OF WORK: The Work of the project shall be substantially completed by March 1, 2024. Time is of the essence.

OPENING OF BIDS: The Bids will be opened publicly and read at 2:00 pm on Tuesday, February 1, 2022, at the above-mentioned office of the Owner.

BID SECURITY: Each Bid shall be accompanied by a certified or cashier's check, or bid bond in the amount of five percent (5%) of the total bid price payable to Jordanelle Special Service District as a guarantee that the Bidder, if his Bid is accepted, will promptly execute the contract, provide evidence of insurance, and furnish a satisfactory faithful performance bond in the amount of 100 percent of the total bid price and a payment bond in the amount of 100 percent of the total bid price.

ADDRESS AND MARKING OF BID: The envelope enclosing the Bid shall be sealed and delivered to the offices of JSSD. The envelope shall be plainly marked in the upper left-hand corner with the name and address of the Bidder and shall bear the words "Bid for," followed by the title of the Contract Documents for the Work and the date and hour of opening of Bids. The certified or cashier's check, or Bidder's bond shall be enclosed in the same envelope with the Bid.

PROJECT ADMINISTRATION: All questions relative to this project prior to the opening of Bids shall be directed to the Engineer for the Project.

Engineering Firm Name: Bowen Collins & Associates
Telephone: 801-495-2224
Fax: 801-495-2225
Contact: Nate Rogers, PE
Email: nrogers@bowencollins.com

It shall be understood, however, that no interpretations of the drawings or specifications will be made except in writing signed by the Engineer, nor will any "or equal" products be considered for approval prior to award of a contract.

OWNER'S RIGHTS RESERVED: The Owner may, at reasonable times, inspect the part of the plant or place of business of a contractor or any subcontractor, which is related to the performance of any contract awarded or to be awarded by the Owner. The Owner reserves the right to reject any or all Bids, to waive any informality in a Bid, and to make awards in the interest of the Owner.

Owner

December 15, 2021
Date

Max Covey
General Manager

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SECTION 00 11 20
PRE-QUALIFIED CONTRACTORS

Jordanelle Special Service District has pre-qualified General Contractors to submit a bid for the JSSD Old Hwy 40 Pump Station and Treatment Project (Fisher Ranch Water Treatment Plant). Only those contractors who have been prequalified are eligible to submit a bid on this project. The following General Contractors (listed in alphabetical order) have been prequalified to bid on this project.

1. Alder Construction
   3939 South 500 West, Suite 1
   Salt Lake City, UT 84123

2. Ames Construction
   3737 West 2100 South
   West Valley City, Utah 84120

3. Archer Western
   299 South Main Street, Suite 1300
   Salt Lake City, UT 84111

4. Bodell Construction
   586 Fine Drive
   Salt Lake City, UT 84115

5. COP Construction
   555 West 1100 North
   North Salt Lake, UT 84054

6. Gerber Construction
   815 East 675 South
   Lehi, UT 84043

7. Ralph L. Wadsworth Construction
   166 East 14000 South
   Draper, Utah 84065

8. VanCon Inc.
   1825 Mountain Springs Parkway
   Springville, UT 84663

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SECTION 00 21 13
INSTRUCTIONS TO BIDDERS

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ARTICLE 1 – DEFINED TERMS

1.01 Terms used in these Instructions to Bidders have the meanings indicated in the General Conditions and Supplementary Conditions. Additional terms used in these Instructions to Bidders have the meanings indicated below:

A. *Issuing Office – Jordanelle Special Service District (Owner).*

ARTICLE 2 – COPIES OF BIDDING DOCUMENTS

2.01 Complete sets of the Bidding Documents may be obtained from the Issuing Office in the number and format stated in the advertisement or invitation to bid.

2.02 Complete sets of Bidding Documents shall be used in preparing Bids; neither Owner nor Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

2.03 Owner and Engineer, in making copies of Bidding Documents available on the above terms, do so only for the purpose of obtaining Bids for the Work and do not authorize or confer a license for any other use.

ARTICLE 3 – QUALIFICATIONS OF BIDDERS

3.01 The Owner has pre-qualified general contractors to bid on this project. Only those general contractors are eligible to bid on this project. Pre-qualified general contractors are listed in Section 00 11 20 – Pre-Qualified Contractors.

3.02 Bidder is advised to carefully review those portions of the Bid Form requiring Bidder's representations and certifications.

ARTICLE 4 – SITE AND OTHER AREAS; EXISTING SITE CONDITIONS; EXAMINATION OF SITE; OWNER'S SAFETY PROGRAM; OTHER WORK AT THE SITE

4.01 *Site and Other Areas*

A. The Site is identified in the Bidding Documents. By definition, the Site includes rights-of-way, easements, and other lands furnished by Owner for the use of the Contractor. Any additional lands required for temporary construction facilities, construction equipment, or storage of materials and equipment, and any access needed for such additional lands, are to be obtained and paid for by Contractor.

4.02 *Existing Site Conditions*

A. Subsurface and Physical Conditions; Hazardous Environmental Conditions

1. The Supplementary Conditions identify:

a. Those reports known to Owner of explorations and tests of subsurface conditions at or adjacent to the Site.

b. Those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities).

c. Reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site.

d. Technical Data contained in such reports and drawings.

2. Owner will make copies of reports and drawings referenced above available to any Bidder on request. These reports and drawings are not part of the Contract Documents, but the Technical Data contained therein upon whose accuracy Bidder is entitled to rely, as provided in the General Conditions, has been identified and established in the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any Technical Data or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings.

3. If the Supplementary Conditions do not identify Technical Data, the default definition of Technical Data set forth in Article 1 of the General Conditions will apply.

4. Geotechnical Baseline Report: The Bidding Documents contain a Geotechnical Baseline Report (GBR). The GBR describes certain select subsurface conditions that are anticipated to be encountered by Contractor during construction in specified locations ("Baseline Conditions"). The GBR is a Contract Document.

   The Baseline Conditions in the GBR are intended to reduce uncertainty and the degree of contingency in submitted Bids. However, Bidders cannot rely solely on the Baseline Conditions. Bids should be based on a comprehensive approach that includes an independent review and analysis of the GBR, all other Contract Documents, Technical Data, other available information, and observable surface conditions. Not all potential subsurface conditions are baselined.

   Nothing in the GBR is intended to relieve Bidders of the responsibility to make their own determinations regarding construction costs, bidding strategies, and Bid prices, nor of the responsibility to select and be responsible for the means, methods, techniques, sequences, and procedures of construction, and for safety precautions and programs incident thereto.

B. Underground Facilities: Information and data shown or indicated in the Bidding Documents with respect to existing Underground Facilities at or contiguous to the Site are set forth in the Contract Documents and are based upon information and data furnished to Owner and Engineer by owners of such Underground Facilities, including Owner, or others.

C. Adequacy of Data: Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to subsurface conditions, other physical conditions, and Underground Facilities, and possible changes in the Bidding Documents due to differing or unanticipated subsurface or physical conditions appear in Paragraphs 5.03, 5.04, and 5.05 of the General Conditions. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to a Hazardous Environmental Condition at the Site, if any, and possible changes in the Contract Documents due to any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work, appear in Paragraph 5.06 of the General Conditions.

4.03 *Site Visit and Testing by Bidders*

A. Bidder shall conduct the required Site visit during normal working hours, and shall not disturb any ongoing operations at the Site.

B. Bidder is not required to conduct any subsurface testing, or exhaustive investigations of Site conditions.

C. On request, and to the extent Owner has control over the Site, and schedule permitting, the Owner will provide Bidder access to the Site to conduct such additional examinations, investigations, explorations, tests, and studies as Bidder deems necessary for preparing and submitting a successful Bid. Owner will not have any obligation to grant such access if doing so is not practical because of existing operations, security or safety concerns, or restraints on Owner's authority regarding the Site.

D. Bidder shall comply with all applicable Laws and Regulations regarding excavation and location of utilities, obtain all permits, and comply with all terms and conditions established by Owner or by property owners or other entities controlling the Site with respect to schedule, access, existing operations, security, liability insurance, and applicable safety programs.

E. Bidder shall fill all holes and clean up and restore the Site to its former condition upon completion of such explorations, investigations, tests, and studies.

4.04 *Owner's Safety Program*

A. Site visits and work at the Site may be governed by an Owner safety program. As the General Conditions indicate, if an Owner safety program exists, it will be noted in the Supplementary Conditions.

4.05 *Other Work at the Site*

A. Reference is made to Article 8 of the Supplementary Conditions for the identification of the general nature of other work of which Owner is aware (if any) that is to be performed at the Site by Owner or others (such as utilities and other prime contractors) and relates to the Work contemplated by these Bidding Documents. If Owner is party to a written contract for such other work, then on request, Owner will provide to each Bidder access to examine such contracts (other than portions thereof related to price and other confidential matters), if any.

ARTICLE 5 – BIDDER'S REPRESENTATIONS

5.01 It is the responsibility of each Bidder before submitting a Bid to:

A. Examine and carefully study the Bidding Documents, and any data and reference items identified in the Bidding Documents;

B. Visit the Site, conduct a thorough, alert visual examination of the Site and adjacent areas, and become familiar with and satisfy itself as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work;

C. Become familiar with and satisfy itself as to all Laws and Regulations that may affect cost, progress, and performance of the Work;

D. Carefully study all: (1) reports of explorations and tests of subsurface conditions at or adjacent to the Site and all drawings of physical conditions relating to existing surface or

subsurface structures at the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings, and (2) reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings;

E. Consider the information known to Bidder itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Site-related reports and drawings identified in the Bidding Documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the Work; (2) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder; and (3) Bidder's safety precautions and programs;

F. Agree, based on the information and observations referred to in the preceding paragraph, that at the time of submitting its Bid no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of its Bid for performance of the Work at the price bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents;

G. Become aware of the general nature of the work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents;

H. Promptly give Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder discovers in the Bidding Documents and confirm that the written resolution thereof by Engineer is acceptable to Bidder;

I. Determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance and furnishing of the Work; and

J. Agree that the submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article, that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

ARTICLE 6 – PRE-BID CONFERENCE

6.01 A mandatory pre-Bid conference will be held at the time and location stated in the invitation or advertisement to bid. Representatives of Owner and Engineer will be present to discuss the Project. Bidders are required to attend and participate in the conference. Engineer will transmit to all prospective Bidders of record such Addenda as Engineer considers necessary in response to questions arising at the conference. Oral statements may not be relied upon and will not be binding or legally effective.

ARTICLE 7 – INTERPRETATIONS AND ADDENDA

7.01 All questions about the meaning or intent of the Bidding Documents are to be submitted to Engineer in writing. Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda delivered to all parties recorded as having received the Bidding Documents. Questions received less than seven days prior to the

date for opening of Bids may not be answered. Only questions answered by Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

7.02 Addenda may be issued to clarify, correct, supplement, or change the Bidding Documents.

ARTICLE 8 – BID SECURITY

8.01 A Bid must be accompanied by Bid security made payable to Owner in an amount of 5 percent of Bidder's maximum Bid price (determined by adding the base bid and all alternates) and in the form of a certified check, bank money order, or a Bid bond (on the form included in the Bidding Documents) issued by a surety meeting the requirements of Paragraphs 6.01 and 6.02 of the General Conditions.

8.02 The Bid security of the apparent Successful Bidder will be retained until Owner awards the contract to such Bidder, and such Bidder has executed the Contract Documents, furnished the required contract security, and met the other conditions of the Notice of Award, whereupon the Bid security will be released. If the Successful Bidder fails to execute and deliver the Contract Documents and furnish the required contract security within 15 days after the Notice of Award, Owner may consider Bidder to be in default, annul the Notice of Award, and the Bid security of that Bidder will be forfeited. Such forfeiture shall be Owner's exclusive remedy if Bidder defaults.

8.03 The Bid security of other Bidders that Owner believes to have a reasonable chance of receiving the award may be retained by Owner until the earlier of seven days after the Effective Date of the Contract or 61 days after the Bid opening, whereupon Bid security furnished by such Bidders will be released.

8.04 Bid security of other Bidders that Owner believes do not have a reasonable chance of receiving the award will be released within seven days after the Bid opening.

ARTICLE 9 – CONTRACT TIMES

9.01 The dates by which the Work is to be substantially completed and ready for final payment are set forth in the Agreement.

ARTICLE 10 – LIQUIDATED DAMAGES

10.01 Provisions for liquidated damages, if any, for failure to timely attain Substantial Completion, or completion of the Work in readiness for final payment, are set forth in the Agreement.

ARTICLE 11 – SUBSTITUTE AND "OR-EQUAL" ITEMS

11.01 The Contract for the Work, as awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents without consideration during the bidding and Contract award process of possible substitute or "or-equal" items. In cases in which the Contract allows the Contractor to request that Engineer authorize the use of a substitute or "or-equal" item of material or equipment, application for such acceptance may not be made to and will not be considered by Engineer until after the Effective Date of the Contract.

11.02 All prices that Bidder sets forth in its Bid shall be based on the presumption that the Contractor will furnish the materials and equipment specified or described in the Bidding

Documents, as supplemented by Addenda. Any assumptions regarding the possibility of post-Bid approvals of "or-equal" or substitution requests are made at Bidder's sole risk.

ARTICLE 12 – SUBCONTRACTORS, SUPPLIERS, AND OTHERS

12.01 A Bidder shall be prepared to retain specific Subcontractors, Suppliers, or other individuals or entities for the performance of the Work if required by the Bidding Documents (most commonly in the Specifications) to do so. If a prospective Bidder objects to retaining any such Subcontractor, Supplier, or other individual or entity, and the concern is not relieved by an Addendum, then the prospective Bidder should refrain from submitting a Bid.

12.02 Subsequent to the submittal of the Bid, Owner may not require the Successful Bidder or Contractor to retain any Subcontractor, Supplier, or other individual or entity against which Contractor has reasonable objection.

12.03 The apparent Successful Bidder, and any other Bidder so requested, shall within 5 days after Bid Opening, submit to the Owner an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor, Supplier, or other individual or entity, if requested. If requested by Owner, such list shall be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor, Supplier, or other individual or entity. If Owner or Engineer, after due investigation, has reasonable objection to any proposed Subcontractor, Supplier, individual, or entity, Owner may, before the Notice of Award is given, request apparent Successful Bidder to submit an acceptable substitute, in which case apparent Successful Bidder shall submit a substitute, Bidder's Bid price will be increased (or decreased) by the difference in cost occasioned by such substitution, and Owner may consider such price adjustment in evaluating Bids and making the Contract award.

12.04 If apparent Successful Bidder declines to make any such substitution, Owner may award the Contract to the next lowest Bidder that proposes to use acceptable Subcontractors, Suppliers, or other individuals or entities. Declining to make requested substitutions will constitute grounds for forfeiture of the Bid security of any Bidder. Any Subcontractor, Supplier, individual, or entity so listed and against which Owner or Engineer makes no written objection prior to the giving of the Notice of Award will be deemed acceptable to Owner and Engineer subject to subsequent revocation of such acceptance as provided in Paragraph 7.06 of the General Conditions.

ARTICLE 13 – PREPARATION OF BID

13.01 The Bid Form is included with the Bidding Documents.

A. All blanks on the Bid Form shall be completed in ink and the Bid Form signed in ink. Erasures or alterations shall be initialed in ink by the person signing the Bid Form. A Bid price shall be indicated for each section, Bid item, alternate, adjustment unit price item, and unit price item listed therein.

B. If the Bid Form expressly indicates that submitting pricing on a specific alternate item is optional, and Bidder elects to not furnish pricing for such optional alternate item, then Bidder may enter the words "No Bid" or "Not Applicable."

13.02 A Bid by a corporation shall be executed in the corporate name by a corporate officer (whose title must appear under the signature), accompanied by evidence of authority to sign. The corporate address and state of incorporation shall be shown.

13.03 A Bid by a limited liability company shall be executed in the name of the firm by a member or other authorized person and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm shall be shown.

13.04 A Bid by an individual shall show the Bidder's name and official address.

13.05 A Bid by a joint venture shall be executed by an authorized representative of each joint venturer in the manner indicated on the Bid Form. The official address of the joint venture shall be shown.

13.06 All names shall be printed in ink below the signatures.

13.07 The Bid shall contain an acknowledgment of receipt of all Addenda, the numbers of which shall be filled in on the Bid Form.

13.08 Postal and e-mail addresses and telephone number for communications regarding the Bid shall be shown.

13.09 The Bid shall contain evidence of Bidder's authority and qualification to do business in the state where the Project is located, or Bidder shall covenant in writing to obtain such authority and qualification prior to award of the Contract and attach such covenant to the Bid. Bidder's state contractor license number, if any, shall also be shown on the Bid Form.

ARTICLE 14 – BASIS OF BID

14.01 *Lump Sum*

A. Bidders shall submit a Bid on a lump sum basis as set forth in the Bid Form.

ARTICLE 15 – SUBMITTAL OF BID

15.01 With each copy of the Bidding Documents, a Bidder is furnished one separate unbound copy of the Bid Form, and, if required, the Bid Bond Form. The unbound copy of the Bid Form is to be completed and submitted with the Bid security and the other documents required to be submitted under the terms of Article 7 of the Bid Form.

15.02 A Bid shall be received no later than the date and time prescribed and at the place indicated in the advertisement or invitation to bid and shall be enclosed in a plainly marked package with the Project title (and, if applicable, the designated portion of the Project for which the Bid is submitted), the name and address of Bidder, and shall be accompanied by the Bid security and other required documents. If a Bid is sent by mail or other delivery system, the sealed envelope containing the Bid shall be enclosed in a separate package plainly marked on the outside with the notation "BID ENCLOSED."

15.03 Bids received after the date and time prescribed for the opening of bids, or not submitted at the correct location or in the designated manner, will not be accepted and will be returned to the Bidder unopened.

ARTICLE 16 – MODIFICATION AND WITHDRAWAL OF BID

16.01 A Bid may be withdrawn by an appropriate document duly executed in the same manner that a Bid must be executed and delivered to the place where Bids are to be submitted prior to the date and time for the opening of Bids. Upon receipt of such notice, the unopened Bid will be returned to the Bidder.

16.02 If a Bidder wishes to modify its Bid prior to Bid opening, Bidder must withdraw its initial Bid in the manner specified in Paragraph 16.01 and submit a new Bid prior to the date and time for the opening of Bids.

ARTICLE 17 – OPENING OF BIDS

17.01 Bids will be opened at the time and place indicated in the advertisement or invitation to bid and, unless obviously non-responsive, read aloud publicly. An abstract of the amounts of the base Bids and major alternates, if any, will be made available to Bidders after the opening of Bids.

ARTICLE 18 – BIDS TO REMAIN SUBJECT TO ACCEPTANCE

18.01 All Bids will remain subject to acceptance for the period of time stated in the Bid Form, but Owner may, in its sole discretion, release any Bid and return the Bid security prior to the end of this period.

ARTICLE 19 – EVALUATION OF BIDS AND AWARD OF CONTRACT

19.01 Owner reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. Owner will reject the Bid of any Bidder that Owner finds, after reasonable inquiry and evaluation, to not be responsible. If Bidder purports to add terms or conditions to its Bid, takes exception to any provision of the Bidding Documents, or attempts to alter the contents of the Contract Documents for purposes of the Bid, then the Owner will reject the Bid as nonresponsive; provided that Owner also reserves the right to waive all minor informalities not involving price, time, or changes in the Work.

19.02 In evaluating Bids, Owner will consider whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices, and other data, as may be requested in the Bid Form or prior to the Notice of Award.

19.03 In evaluating whether a Bidder is responsible, Owner will consider the qualifications of the Bidder and may consider the qualifications and experience of Subcontractors and Suppliers proposed for those portions of the Work for which the identity of Subcontractors and Suppliers must be submitted as provided in the Bidding Documents.

19.04 Owner may conduct such investigations as Owner deems necessary to establish the responsibility, qualifications, and financial ability of Bidders and any proposed Subcontractors or Suppliers.

19.05 More than one Bid for the same Work from an individual or entity under the same or different names will not be considered. Reasonable grounds for believing that any Bidder has an interest in more than one Bid for the Work may be cause for disqualification of that Bidder and the rejection of all Bids in which that Bidder has an interest.

19.06 If the Contact is to be awarded, Owner will award the Contract to the Bidder whose Bid is in the best interest of the Project.

ARTICLE 20 – BONDS AND INSURANCE

20.01 Article 6 of the General Conditions, as may be modified by the Supplementary Conditions, sets forth Owner's requirements as to performance and payment bonds and insurance. When the Successful Bidder delivers the Agreement (executed by Successful Bidder) to Owner, it shall be accompanied by required bonds and insurance documentation.

ARTICLE 21 – SIGNING OF AGREEMENT

21.01 It is customary for Owner to fill in the date on the signature page of the Agreement in order to indicate when it is to become effective (the Effective Date of the Contract) so that the required bonds may be properly dated. When Owner issues a Notice of Award to the Successful Bidder, it shall be accompanied by the unexecuted counterparts of the Agreement along with the other Contract Documents as identified in the Agreement. Within 15 days thereafter, Successful Bidder shall execute and deliver the required number of counterparts of the Agreement (and any bonds and insurance documentation required to be delivered by the Contract Documents) to Owner. Within ten days thereafter, Owner shall deliver one fully executed counterpart of the Agreement to Successful Bidder, together with printed and electronic copies of the Contract Documents as stated in Paragraph 2.02 of the General Conditions.

ARTICLE 22 – SALES AND USE TAXES

22.01 State and local taxes, excises and license fees, as required by the laws and statutes of the state and its political subdivisions, shall be paid by the Contractor. Prices quoted in the Bid Forms shall include sales and use taxes, unless provisions are made in the Bid forms to separately itemize taxes.

ARTICLE 23 – PRE-PURCHASED EQUIPMENT

23.01 The Owner has pre-selected and pre-purchased the water treatment system package equipment by AWS Water Solutions Ltd. that is to be installed by the Contractor under his contract.

23.02 The Contractor is responsible for installation and startup coordination with the package equipment. The AWS package equipment submittal is included as part of these contract documents.

END OF SECTION

SECTION 00 41 00
BID FORM

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Jordanelle Special Service District (JSSD)

JSSD Old Hwy 40 Pump Station and Treatment Project (Fisher Ranch Water Treatment Plant)

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ARTICLE 1 – BID RECIPIENT

1.01 This Bid is submitted to:

JSSD

5360 North Old Hwy 40

Heber City, UT 84032

1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Owner in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.

ARTICLE 2 – BIDDER'S ACKNOWLEDGEMENTS

2.01 Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 60 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

ARTICLE 3 – BIDDER'S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

A. Bidder has examined and carefully studied the Bidding Documents, and any data and reference items identified in the Bidding Documents, and hereby acknowledges receipt of the following Addenda:

Addendum No.	**Addendum, Date**
_____	_____
_____	_____
_____	_____
_____	_____

B. Bidder has visited the Site, conducted a thorough, alert visual examination of the Site and adjacent areas, and become familiar with and satisfied itself as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

C. Bidder is familiar with and has satisfied itself as to all Laws and Regulations that may affect cost, progress, and performance of the Work.

D. Bidder has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or adjacent to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings, and (2) reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings.

E. Bidder has considered the information known to Bidder itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and any Site-related reports and drawings identified in the Bidding Documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the Work; (2) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder; and (3) Bidder's safety precautions and programs.

F. Bidder agrees, based on the information and observations referred to in the preceding paragraph, that no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents.

G. Bidder is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.

H. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and confirms that the written resolution thereof by Engineer is acceptable to Bidder.

I. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance and furnishing of the Work.

J. The submission of this Bid constitutes an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article, and that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

ARTICLE 4 – BIDDER'S CERTIFICATION

4.01 Bidder certifies that:

A. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization, or corporation;

B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;

C. Bidder has not solicited or induced any individual or entity to refrain from bidding; and

D. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 4.01.D:

1. "corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process;

2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Owner, (b) to establish bid prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;

3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish bid prices at artificial, non-competitive levels; and

4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

ARTICLE 5 – BASIS OF BID

5.01 Bidder will complete the Work in accordance with the Contract Documents for the following price(s):

BASE BID

Bid Item 1: Lump Sum Bid Price			$_____
Bid Item 2: Lump Sum Contingency Allowances			$ 300,000
Bid Item 3: Lump Sum Integrator Services *			$ TBD
Bid Item 4: Unit Price Imported Fill	Quantity 3,000 CY	Unit Price $ _____ per CY	Extended Price $ _____

Total of All Bid Items (Sum of Items 1 – 4) $_____

_____

Total Bid Amount in Words

**Final Cost of Integrator Services will be provided by Addendum prior to bid opening.*

Equipment Bid Item A – On-Site SH Generator Supplier Bid: UGSI ** $_____

Equipment Bid Item B – On-Site SH Generator Supplier Bid: MIOX ** $_____

*** See 01 20 00 Measurement and Payment for description of Bid Items A and B. These two bid items include the supply of the On-Site Sodium Hypochlorite Generation (OSHG) system equipment including freight charges, spare parts, training, spare parts and other manufacturers services as identified in 46 33 50 On-Site Sodium Hypochlorite Generation System. Note: The Bidder shall identify which of the two OSHG Suppliers are included in the Bid Item No. 1 price in the form included in Section 00 43 70 - Proposed Subs and Major Material Suppliers.*

ARTICLE 6 – TIME OF COMPLETION

6.01 Bidder agrees that the Work will be substantially complete and will be completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions on or before the dates or within the number of calendar days indicated in the Agreement.

6.02 Bidder accepts the provisions of the Agreement as to liquidated damages.

ARTICLE 7 – ATTACHMENTS TO THIS BID

7.01 The following documents are submitted with and made a condition of this Bid:

A. Required Bid security;

B. Proposed Project Approach and Schedule;

C. Proposed Dewatering Plan;

D. List of Proposed Subcontractors;

E. List of Proposed Equipment Suppliers; and

F. Evidence of authority to do business in the state of the Project; or a written covenant to obtain such license within the time for acceptance of Bids;

ARTICLE 8 – DEFINED TERMS

8.01 The terms used in this Bid with initial capital letters have the meanings stated in the Instructions to Bidders, the General Conditions, and the Supplementary Conditions.

ARTICLE 9 – BID SUBMITTAL

BIDDER: *(Indicate correct name of bidding entity)*

_____

By:
[Signature] _____

[Printed name] _____
(If Bidder is a corporation, a limited liability company, a partnership, or a joint venture, attach evidence of authority to sign.)

Attest:
[Signature] _____

[Printed name] _____

Title: _____

Submittal Date: _____

Address for giving notices:

_____

_____

_____

Telephone Number: _____

Fax Number: _____

Contact Name and e-mail address: _____

_____

Bidder's License No.: _____
(where applicable)

END OF SECTION

SECTION 00 43 14
BID BOND (DAMAGES FORM)

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Any singular reference to Bidder, Surety, Owner or other party shall be considered plural where applicable.

BIDDER (Name and Address):

SURETY (Name, and Address of Principal Place of Business):

OWNER (Name and Address):

BID

Bid Due Date:

Description (Project Name— Include Location):

BOND

Bond Number:

Date:

Penal sum $

(Words) (Figures)

Surety and Bidder, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Bid Bond to be duly executed by an authorized officer, agent, or representative.

BIDDER	SURETY
_____ (Seal)	_____ (Seal)
Bidder's Name and Corporate Seal	Surety's Name and Corporate Seal
By: _____	By: _____
Signature	Signature (Attach Power of Attorney)
_____	_____
Print Name	Print Name
_____	_____
Title	Title
Attest: _____	Attest: _____
Signature	Signature
Title	Title

Note: Addresses are to be used for giving any required notice.
Provide execution by any additional parties, such as joint venturers, if necessary.

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to pay to Owner upon default of Bidder any difference between the total amount of Bidder's Bid and the total amount of the Bid of the next lowest, responsible Bidder that submitted a responsive Bid as determined by Owner for the work required by the Contract Documents, provided that:

1.1 If there is no such next Bidder, and Owner does not abandon the Project, then Bidder and Surety shall pay to Owner the penal sum set forth on the face of this Bond, and

1.2 In no event shall Bidder's and Surety's obligation hereunder exceed the penal sum set forth on the face of this Bond.

1.3 Recovery under the terms of this Bond shall be Owner's sole and exclusive remedy upon default of Bidder.

2. Default of Bidder shall occur upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.

3. This obligation shall be null and void if:

3.1 Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or

3.2 All Bids are rejected by Owner, or

3.3 Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).

4. Payment under this Bond will be due and payable upon default of Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.

5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions shall not in the aggregate exceed 120 days from Bid due date without Surety's written consent.

6. No suit or action shall be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety and in no case later than one year after the Bid due date.

7. Any suit or action under this Bond shall be commenced only in a court of competent jurisdiction located in the state in which the Project is located.

8. Notices required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Registered or Certified Mail, return receipt requested, postage pre-paid, and shall be deemed to be effective upon receipt by the party concerned.

9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.

10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement

of any applicable statute that has been omitted from this Bond shall be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute shall govern and the remainder of this Bond that is not in conflict therewith shall continue in full force and effect.

11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.

END OF SECTION

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SECTION 00 43 50
PROJECT ORGANIZATION DESCRIPTION

Bidder shall attach to this section a description of the organization to be provided for execution of the Contract, including an organization chart with numbers and titles of key personnel and numbers and categories of home office and field personnel. The description shall show lines of authority and communication, together with a written description of the overall working of the Bidder's contract organization, with particular emphasis on the home office and job site interface and the monitoring and control of the progress of the Work.

The organization chart shall include listing of all key personnel, such as, but not limited to:

Project Manager
Assistant Project Manager
Earthworks Superintendent/Foreman
Building/Concrete Superintendent/Foreman
Health and Safety Officer
All other supervisors
Key individuals from subcontractor organizations

[_____]
Name of Bidder

END OF SECTION

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SECTION 00 43 70
PROPOSED SUBCONTRACTORS AND MAJOR MATERIAL SUPPLIERS

Bidder shall submit a list of each subcontractor and major materials suppliers that will be used in the Work if the Bidder is awarded the Contract.

Name	Business Address	Work Description	Percent

[_____]
Name of Bidder

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SECTION 00 43 83
PRELIMINARY CONSTRUCTION SCHEDULE

Bidder shall complete the following bar chart schedule or provide a schedule using an approved similar or better software, adding major construction items for the listed activities at a minimum. The schedule shall indicate the dates for Substantial Completion, Final Completion, and any constraints on performance of the work. Assume Notice to Proceed is issued by March 1, 2022 (Dates shown in the bar chart indicate the Monday of each week.)

(Insert appropriate table with major tasks)

Activity	**[Date]**				**[Date]**					**[Date]**				**[Date]**			

[_____]
Name of Bidder

END OF SECTION

SECTION 00 45 10
CONTRACTOR'S CURRENT BUSINESS LICENSE INFORMATION

Bidder shall attach to this section a copy of the Bidder's current business license information.

[_____]
Name of Bidder

END OF DOCUMENT

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SECTION 00 51 00
NOTICE OF AWARD

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Date of Issuance:

Owner: JSSD

Owner's Contract No.:

Engineer: Bowen Collins & Associates

Engineer's Project No.: 056-20-01

Project: JSSD Old Hwy 40 Pump Station and Treatment Project (Fisher Ranch Water Treatment Plant)

Contract Name:

Bidder:

Bidder's Address:

TO BIDDER:

You are notified that Owner has accepted your Bid dated [_____] for the above Contract, and that you are the Successful Bidder and are awarded a Contract for:

[_____].

[Describe Work, alternates, or sections of Work awarded]

The Contract Price of the awarded Contract is: $ [_____] *[note if subject to unit prices, or cost-plus]*

[_____] unexecuted counterparts of the Agreement accompany this Notice of Award, and one copy of the Contract Documents accompanies this Notice of Award, or has been transmitted or made available to Bidder electronically. *[Revise if multiple copies accompany the Notice of Award]*

☒ A set of the Drawings will be delivered separately from the other Contract Documents.

You must comply with the following conditions precedent within 15 days of the date of receipt of this Notice of Award:

1. Deliver to Owner [_____] counterparts of the Agreement, fully executed by Bidder.
2. Deliver with the executed Agreement(s) the Contract security *[e.g., performance and payment bonds]* and insurance documentation as specified in the Instructions to Bidders and General Conditions, Articles 2 and 6.
3. Other conditions precedent (if any):

Failure to comply with these conditions within the time specified will entitle Owner to consider you in default, annul this Notice of Award, and declare your Bid security forfeited.

Within ten days after you comply with the above conditions, Owner will return to you one fully executed counterpart of the Agreement, together with any additional copies of the Contract Documents as indicated in Paragraph 2.02 of the General Conditions.

Owner**:**

Authorized Signature

By:

Title:

Copy: Engineer

END OF SECTION

SECTION 00 52 13
AGREEMENT
BETWEEN OWNER AND CONTRACTOR
FOR CONSTRUCTION CONTRACT (STIPULATED PRICE)

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THIS AGREEMENT is by and between Jordanelle Special Service District ("Owner") and _____ ("Contractor").

ARTICLE 1 – WORK

1.01 Contractor shall complete all Work as specified or indicated in the Contract Documents as follows.

DESCRIPTION OF WORK: For the JSSD Old Hwy 40 Pump Station and Treatment Project (Fisher Ranch Water Treatment Plant), the Work of the Contractor comprises construction of a new 24,700 square-foot water treatment plant and pumping facility. The Work generally includes the construction/installation of the following:

1. Construction of a new 4 million gallon per day (mgd) water treatment facility, with anticipated ultimate capacity of 8 mgd
2. The 24,700 square foot building includes the following areas and features:
    a. Main level garage area above the clearwell
    b. Cast in place concrete finished water basement clearwell area below the finished water pump and garage areas
    c. Finished water pump station area with three vertical turbine pumps (with space for two future pumps) and associated surge tank, valves, mechanical piping, flow meter, and electrical.
    d. Snowmaking pump station area with six vertical turbine "canned" pumps and associated surge tank, basket strainer, valves, mechanical piping, flow meter, and electrical
    e. Electrical room and plant power system (with backup diesel generators) and miscellaneous lighting and power systems
    f. Mezzanine finished office space areas, SCADA/controls room, kitchen, and laboratory
    g. Miscellaneous building mechanical systems, HVAC, utilities, security, and piping
    h. CMU building with architectural finishes
3. The installation of Owner purchased/supplied water treatment package system includes the following items:
    a. Installation of owner purchased/supplied water treatment package system (4 mgd total): Four (4) 1 mgd treatment trains, each including valves, flow meters, instrumentation, and walkways. The system generally includes air blowers, flash mixer, flow meters, control valves, PLC controls, and ancillary equipment and instrumentation. The Owner supplied treatment package system submittal is included with these bid documents.
    b. Loading, transportation and off-loading of treatment package equipment from a storage location within 5 miles of the project location.
4. Treatment chemical feed systems in separate containment areas that include:
    a. Caustic Soda feed system with bulk storage and metering pump systems

b. Primary Coagulant feed system with bulk storage and metering pump systems
c. Flocculant Aid Polymer storage, blending, and feed system with storage and metering pumps
d. Installation of new on-site sodium hypochlorite (chlorine) system including on-site generators, power, salt/brine storage system, storage tank, and metering pump systems
e. Chemical controls systems and instrumentation integrated in the plant controls

5. Sludge drying beds (cast in place concrete 100' x 150') with associated access roads, yard piping, valves, and decant pumping system.
6. Plant under-slab piping for treatment equipment piping connections
7. Plant raw water inlet piping system with basket strainers
8. Plant backwash system with PRVs and pressure relief valves and piping.
9. Civil work including raising and leveling the site, new access roads and asphalt parking area, fencing and site security, and general yard piping, site utilities, and drainage.
10. SCADA hardware and integration by Owner's selected Integrator.
11. Other Owner Supplied Equipment:
    a. The following HDPE materials will be supplied by the Owner and furnished at the site:
        i. 300 LF of 42-inch HDPE 4710 DR 26 Pipe
        ii. One 42-inch HDPE 4710 DR 26 45 degree bend
        iii. Two 42-inch PE 4710 DR 26 HDPE Flange Adapters
        iv. Two Backer Rings for 42-inch HDPE Flange Adapters
        - This does not include any hardware (bolt packs, gaskets, etc.)

ARTICLE 2 – THE PROJECT

2.01 The Project, of which the Work under the Contract Documents is a part, is generally described as follows:

Construction of a new surface water treatment plant to treat water from the Provo River for use within the JSSD culinary distribution system. The Project also includes finished water pumping facilities and a separate raw water snowmaking pump station.

ARTICLE 3 – ENGINEER

3.01 The Project has been designed by Bowen Collins & Associates.

3.02 The Owner has retained Bowen Collins & Associates ("Engineer") to act as Owner's representative, assume all duties and responsibilities, and have the rights and authority assigned to Engineer in the Contract Documents in connection with the completion of the Work in accordance with the Contract Documents.

ARTICLE 4 – CONTRACT TIMES

4.01 *Time of the Essence*

A. All time limits for Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

4.02 *Contract Times: Dates*

A. The Contract Times for the Work are as follows:

1. The project Work will be substantially completed on or before March 1, 2024, and completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions on or before May 1, 2024.

4.03 *Liquidated Damages*

A. Contractor and Owner recognize that time is of the essence as stated in Paragraph 4.01 above and that Owner will suffer financial and other losses if the Work is not completed and Milestones not achieved within the times specified in Paragraph 4.02 above, plus any extensions thereof allowed in accordance with the Contract. The parties also recognize the delays, expense, and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty):

1. Substantial Completion: Contractor shall pay Owner $ 1,000 for each day that expires after the time (as duly adjusted pursuant to the Contract) specified in Paragraph 4.02.A above for Substantial Completion until the Work is substantially complete.

2. Final Completion: After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Time (as duly adjusted pursuant to the Contract) for completion and readiness for final payment, Contractor shall pay Owner $ 500 for each day that expires after such time until the Work is completed and ready for final payment.

3. Liquidated damages for failing to timely attain Substantial Completion and final completion are not additive and will not be imposed concurrently.

4.04 *Special Damages (NOT USED)*

ARTICLE 5 – CONTRACT PRICE

5.01 Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents the amounts that follow, subject to adjustment under the Contract:

A. For all Work, a lump sum of: $ _____.

(Words) $ _____

All specific cash allowances are included in the above price in accordance with Paragraph 13.02 of the General Conditions.

ARTICLE 6 – PAYMENT PROCEDURES

6.01 *Submittal and Processing of Payments*

A. Contractor shall submit Applications for Payment in accordance with Article 15 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

6.02 *Progress Payments; Retainage*

A. Owner shall make progress payments on account of the Contract Price on the basis of Contractor's Applications for Payment on or about the 1st day of each following month during performance of the Work as provided in Paragraph 6.02.A.1 below, provided that such Applications for Payment have been submitted in a timely manner and otherwise meet the requirements of the Contract. All such payments will be measured by the Schedule of Values established as provided in the General Conditions or, in the event there is no Schedule of Values, as provided elsewhere in the Contract.

1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Owner may withhold, including but not limited to liquidated damages, in accordance with the Contract

a. 95 percent of Work completed (with the balance being retainage). If the Work has been 50 percent completed as determined by Engineer, and if the character and progress of the Work have been satisfactory to Owner and Engineer, then as long as the character and progress of the Work remain satisfactory to Owner and Engineer, there will be no additional retainage; and

b. 95 percent of cost of materials and equipment not incorporated in the Work (with the balance being retainage).

B. Upon Substantial Completion, Owner shall pay an amount sufficient to increase total payments to Contractor to 100 percent of the Work completed, less such amounts set off by Owner pursuant to Paragraph 15.01.E of the General Conditions, and less 200 percent of Engineer's estimate of the value of Work to be completed or corrected as shown on the punch list of items to be completed or corrected prior to final payment.

6.03 *Final Payment*

A. Upon final completion and acceptance of the Work in accordance with Paragraph 15.06 of the General Conditions, Owner shall pay the remainder of the Contract Price as recommended by Engineer as provided in said Paragraph 15.06.

ARTICLE 7 – INTEREST

7.01 All amounts not paid when due shall bear interest at the maximum rate per annum, as allowed by the State.

ARTICLE 8 – CONTRACTOR'S REPRESENTATIONS

8.01 In order to induce Owner to enter into this Contract, Contractor makes the following representations:

A. Contractor has examined and carefully studied the Contract Documents, and any data and reference items identified in the Contract Documents.

B. Contractor has visited the Site, conducted a thorough, alert visual examination of the Site and adjacent areas, and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

C. Contractor is familiar with and is satisfied as to all Laws and Regulations that may affect cost, progress, and performance of the Work.

D. Contractor has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or adjacent to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings, and (2) reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings.

E. Contractor has considered the information known to Contractor itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Contract Documents; and the Site-related reports and drawings identified in the Contract Documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the Work; (2) the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor; and (3) Contractor's safety precautions and programs.

F. Based on the information and observations referred to in the preceding paragraph, Contractor agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract.

G. Contractor is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.

H. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.

I. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

J. Contractor's entry into this Contract constitutes an incontrovertible representation by Contractor that without exception all prices in the Agreement are premised upon performing and furnishing the Work required by the Contract Documents.

ARTICLE 9 – CONTRACT DOCUMENTS

9.01 *Contents*

A. The Contract Documents consist of the following:

1. This Agreement.
2. Performance bond.
3. Payment bond.
4. General Conditions.
5. Supplementary Conditions.
6. Specifications as listed in the table of contents of the Project Manual.
7. Drawings
8. Owner Purchased WTP Equipment Submittal
9. Addenda
10. Exhibits to this Agreement (enumerated as follows):
    a. Contractor's Bid.
11. The following which may be delivered or issued on or after the Effective Date of the Contract and are not attached hereto:
    a. Notice to Proceed.
    b. Work Change Directives.
    c. Change Orders.
    d. Field Orders.

B. The documents listed in Paragraph 9.01.A are attached to this Agreement (except as expressly noted otherwise above).

C. There are no Contract Documents other than those listed above in this Article 9.

D. The Contract Documents may only be amended, modified, or supplemented as provided in the General Conditions.

ARTICLE 10 – MISCELLANEOUS

10.01 *Terms*

A. Terms used in this Agreement will have the meanings stated in the General Conditions and the Supplementary Conditions.

10.02 *Assignment of Contract*

A. Unless expressly agreed to elsewhere in the Contract, no assignment by a party hereto of any rights under or interests in the Contract will be binding on another party hereto without the written consent of the party sought to be bound; and, specifically but without limitation, money that may become due and money that is due may not be assigned without such consent (except to the extent that the effect of this restriction may be

limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

10.03 *Successors and Assigns*

A. Owner and Contractor each binds itself, its successors, assigns, and legal representatives to the other party hereto, its successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

10.04 *Severability*

A. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon Owner and Contractor, who agree that the Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

10.05 *Contractor's Certifications*

A. Contractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract. For the purposes of this Paragraph 10.05:

1. "corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process or in the Contract execution;

2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Contract to the detriment of Owner, (b) to establish Bid or Contract prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;

3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, non-competitive levels; and

4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

10.06 *Other Provisions*

A. Owner stipulates that if the General Conditions that are made a part of this Contract are based on EJCDC® C-700, Standard General Conditions for the Construction Contract, published by the Engineers Joint Contract Documents Committee®, and if Owner is the party that has furnished said General Conditions, then Owner has plainly shown all modifications to the standard wording of such published document to the Contractor, through a process such as highlighting or "track changes" (redline/strikeout), or in the Supplementary Conditions.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement.

This Agreement will be effective on _____ (which is the Effective Date of the Contract).

OWNER:	CONTRACTOR:
_____	_____
By: _____	By: _____
Title: _____	Title: _____ *(If Contractor is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)*
Attest: _____	Attest: _____
Title: _____	Title: _____
Address for giving notices:	Address for giving notices:
_____	_____
_____	_____
_____	_____
	License No.: _____ *(where applicable)*
(If Owner is a corporation, attach evidence of authority to sign. If Owner is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of this Agreement.)	*NOTE TO USER: Use in those states or other jurisdictions where applicable or required.*

END OF SECTION

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SECTION 00 55 00
NOTICE TO PROCEED

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Owner:	Jordanelle Special Services District	Owner's Contract No.:	
Contractor:	_____	Contractor's Project No.:	
Engineer:	Bowen Collins & Associates	Engineer's Project No.:	056-20-01
Project:	JSSD Old Hwy 40 Pump Station and Treatment Project (Fisher Ranch Water Treatment Plant)	Contract Name:	
		Effective Date of Contract:	

TO CONTRACTOR:

Owner hereby notifies Contractor that the Contract Times under the above Contract will commence to run on _____.

On that date, Contractor shall start performing its obligations under the Contract Documents. No Work shall be done at the Site prior to such date.
In accordance with the Agreement, the date of Substantial Completion is _____ and the date of readiness for final payment is _____.
Before starting any work at the Site, Contractor must comply with the following:

No restrictions have been identified for this project.

Owner**:**

_____
Authorized Signature

By:

Title:

Date Issued:

Copy: Engineer

END OF SECTION

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SECTION 00 61 14
PERFORMANCE BOND

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CONTRACTOR *(name and address)*:

SURETY *(name and address of principal place of business)*:

OWNER *(name and address)*:

CONSTRUCTION CONTRACT

Effective Date of the Agreement:
Amount:
Description *(name and location)*:

BOND

Bond Number:
Date *(not earlier than the Effective Date of the Agreement of the Construction Contract)*:
Amount:
Modifications to this Bond Form: ☐ See Paragraph 16 ☐ None

Surety and Bidder, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Performance Bond to be duly executed by an authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL	**SURETY**
_____ (Seal)	_____ (Seal)
Contractor's Name and Corporate Seal	Surety's Name and Corporate Seal
By: _____	By: _____
Signature	Signature (Attach Power of Attorney)
_____	_____
Print Name	Print Name
_____	_____
Title	Title
Attest: _____	_____
Signature	Signature
_____	_____
Title	Title

Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.

2. If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Paragraph 3.

3. If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond shall arise after:

3.1 The Owner first provides notice to the Contractor and the Surety that the Owner is considering declaring a Contractor Default. Such notice shall indicate whether the Owner is requesting a conference among the Owner, Contractor, and Surety to discuss the Contractor's performance. If the Owner does not request a conference, the Surety may, within five (5) business days after receipt of the Owner's notice, request such a conference. If the Surety timely requests a conference, the Owner shall attend. Unless the Owner agrees otherwise, any conference requested under this Paragraph 3.1 shall be held within ten (10) business days of the Surety's receipt of the Owner's notice. If the Owner, the Contractor, and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement shall not waive the Owner's right, if any, subsequently to declare a Contractor Default;

3.2 The Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and

3.3 The Owner has agreed to pay the Balance of the Contract Price in accordance with the terms of the Construction Contract to the Surety or to a contractor selected to perform the Construction Contract.

4. Failure on the part of the Owner to comply with the notice requirement in Paragraph 3.1 shall not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.

5. When the Owner has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:

5.1 Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;

5.2 Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;

5.3 Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and a contractor selected with the Owners concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Paragraph 7 in excess of the Balance of the Contract Price incurred by the Owner as a result of the Contractor Default; or

5.4 Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:

5.4.1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, make payment to the Owner; or

5.4.2 Deny liability in whole or in part and notify the Owner, citing the reasons for denial.

6. If the Surety does not proceed as provided in Paragraph 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Paragraph 5.4, and the Owner refuses the payment or the Surety has denied liability, in whole or in part, without further notice the Owner shall be entitled to enforce any remedy available to the Owner.

7. If the Surety elects to act under Paragraph 5.1, 5.2, or 5.3, then the responsibilities of the Surety to the Owner shall not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety shall not be greater than those of the Owner under the Construction Contract. Subject to the commitment by the Owner to pay the Balance of the Contract Price, the Surety is obligated, without duplication for:

7.1 the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;

7.2 additional legal, design professional, and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph 5; and

7.3 liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.

8. If the Surety elects to act under Paragraph 5.1, 5.3, or 5.4, the Surety's liability is limited to the amount of this Bond.

9. The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the

Construction Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors, and assigns.

10. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.

11. Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and shall be instituted within two years after a declaration of Contractor Default or within two years after the Contractor ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum periods of limitations available to sureties as a defense in the jurisdiction of the suit shall be applicable.

12. Notice to the Surety, the Owner, or the Contractor shall be mailed or delivered to the address shown on the page on which their signature appears.

13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

14. Definitions

14.1 Balance of the Contract Price: The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made including allowance for the Contractor for any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.

14.2 Construction Contract: The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and changes made to the agreement and the Contract Documents.

14.3 Contractor Default: Failure of the Contractor, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Construction Contract.

14.4 Owner Default: Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

14.5 Contract Documents: All the documents that comprise the agreement between the Owner and Contractor.

15. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

16. Modifications to this Bond are as follows:

END OF SECTION

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SECTION 00 61 15
PAYMENT BOND

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CONTRACTOR *(name and address)*:

SURETY *(name and address of principal place of business)*:

OWNER *(name and address)*:

CONSTRUCTION CONTRACT

Effective Date of the Agreement:
Amount:
Description *(name and location)*:

BOND

Bond Number:
Date *(not earlier than the Effective Date of the Agreement of the Construction Contract)*:
Amount:
Modifications to this Bond Form: ☒ None ☐ See Paragraph 18

Surety and Bidder, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL	**SURETY**
_____ (Seal)	_____ (Seal)
Contractor's Name and Corporate Seal	Surety's Name and Corporate Seal
By: _____	By: _____
Signature	Signature (Attach Power of Attorney)
_____	_____
Print Name	Print Name
_____	_____
Title	Title
Attest: _____	_____
Signature	Signature
_____	_____
Title	Title

Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner to pay for labor, materials, and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference, subject to the following terms.

2. If the Contractor promptly makes payment of all sums due to Claimants, and defends, indemnifies, and holds harmless the Owner from claims, demands, liens, or suits by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, then the Surety and the Contractor shall have no obligation under this Bond.

3. If there is no Owner Default under the Construction Contract, the Surety's obligation to the Owner under this Bond shall arise after the Owner has promptly notified the Contractor and the Surety (at the address described in Paragraph 13) of claims, demands, liens, or suits against the Owner or the Owner's property by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, and tendered defense of such claims, demands, liens, or suits to the Contractor and the Surety.

4. When the Owner has satisfied the conditions in Paragraph 3, the Surety shall promptly and at the Surety's expense defend, indemnify, and hold harmless the Owner against a duly tendered claim, demand, lien, or suit.

5. The Surety's obligations to a Claimant under this Bond shall arise after the following:

5.1 Claimants who do not have a direct contract with the Contractor,

5.1.1 have furnished a written notice of non-payment to the Contractor, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were, or equipment was, furnished or supplied or for whom the labor was done or performed, within ninety (90) days after having last performed labor or last furnished materials or equipment included in the Claim; and

5.1.2 have sent a Claim to the Surety (at the address described in Paragraph 13).

5.2 Claimants who are employed by or have a direct contract with the Contractor have sent a Claim to the Surety (at the address described in Paragraph 13).

6. If a notice of non-payment required by Paragraph 5.1.1 is given by the Owner to the Contractor, that is sufficient to satisfy a Claimant's obligation to furnish a written notice of non-payment under Paragraph 5.1.1.

7. When a Claimant has satisfied the conditions of Paragraph 5.1 or 5.2, whichever is applicable, the Surety shall promptly and at the Surety's expense take the following actions:

7.1 Send an answer to the Claimant, with a copy to the Owner, within sixty (60) days after receipt of the Claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and

7.2 Pay or arrange for payment of any undisputed amounts.

7.3 The Surety's failure to discharge its obligations under Paragraph 7.1 or 7.2 shall not be deemed to constitute a waiver of defenses the Surety or Contractor may have or acquire as to a Claim, except as to undisputed amounts for which the Surety and Claimant have reached agreement. If, however, the Surety fails to discharge its obligations under Paragraph 7.1 or 7.2, the Surety shall indemnify the Claimant for the reasonable attorney's fees the Claimant incurs thereafter to recover any sums found to be due and owing to the Claimant.

8. The Surety's total obligation shall not exceed the amount of this Bond, plus the amount of reasonable attorney's fees provided under Paragraph 7.3, and the amount of this Bond shall be credited for any payments made in good faith by the Surety.

9. Amounts owed by the Owner to the Contractor under the Construction Contract shall be used for the performance of the Construction Contract and to satisfy claims, if any, under any construction performance bond. By the Contractor furnishing and the Owner accepting this Bond, they agree that all funds earned by the Contractor in the performance of the Construction Contract are dedicated to satisfy obligations of the Contractor and Surety under this Bond, subject to the Owner's priority to use the funds for the completion of the work.

10. The Surety shall not be liable to the Owner, Claimants, or others for obligations of the Contractor that are unrelated to the Construction Contract. The Owner shall not be liable for the payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to or give notice on behalf of Claimants, or otherwise have any obligations to Claimants under this Bond.

11. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.

12. No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the state in which the project that is the subject of the Construction Contract is located or after the expiration of one year from the date (1) on which the Claimant sent a Claim to the Surety pursuant to Paragraph 5.1.2 or 5.2, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone

under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

13. Notice and Claims to the Surety, the Owner, or the Contractor shall be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, shall be sufficient compliance as of the date received.

14. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

15. Upon requests by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor and Owner shall promptly furnish a copy of this Bond or shall permit a copy to be made.

16. Definitions

16.1 Claim: A written statement by the Claimant including at a minimum:

1. The name of the Claimant;

2. The name of the person for whom the labor was done, or materials or equipment furnished;

3. A copy of the agreement or purchase order pursuant to which labor, materials, or equipment was furnished for use in the performance of the Construction Contract;

4. A brief description of the labor, materials, or equipment furnished;

5. The date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Construction Contract;

6. The total amount earned by the Claimant for labor, materials, or equipment furnished as of the date of the Claim;

7. The total amount of previous payments received by the Claimant; and

8. The total amount due and unpaid to the Claimant for labor, materials, or equipment furnished as of the date of the Claim.

16.2 Claimant: An individual or entity having a direct contract with the Contractor or with a subcontractor of the Contractor to furnish labor, materials, or equipment for use in the performance of the Construction Contract. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic's lien or similar statute against the real property upon which the Project is located. The intent of this Bond shall be to include without limitation in the terms of "labor, materials, or equipment" that part of the water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Construction Contract, architectural and engineering services required for performance of the work of the Contractor and the Contractor's subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.

16.3 Construction Contract: The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and all changes made to the agreement and the Contract Documents.

16.4 Owner Default: Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

16.5 Contract Documents: All the documents that comprise the agreement between the Owner and Contractor.

17. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

18. Modifications to this Bond are as follows:

END OF SECTION

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SECTION 00 62 76
CONTRACTOR'S APPLICATION FOR PAYMENT

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Contractor's Application for Payment No. ____

	Application Period: From To	Application Date:
To (Owner): Jordanelle Special Service District	From (Contractor):	Via (Engineer): Bowen Collins & Associates
Project: Fisher Ranch Water Treatment Plant	Contract:	
Owner's Contract No:	Contractor's Project No:	Engineer's Project N0: 056-20-01

Application For Payment

Change Order Summary

Approved Change Orders

Number	Additions	Deductions
TOTALS		
NET CHANGE BY CHANGE ORDERS		

1. ORIGINAL CONTRACT PRICE ..... ____
2. Net change by Change Orders ..... ____
3. Current Contract Price (Line 1 ± Line 2) ..... ____
4. TOTAL COMPLETED AND STORED TO DATE (Column F total on Progress Estimates) ..... ____
5. RETAINAGE
   a. ____ X ____ Work Completed ..... ____
   b. ____ X ____ Stored Material ..... ____
   c. Total retainage (Line 5a + Line 5b ..... ____
6. AMOUNT ELIGIBLE TO DATE (Line 4 - Line 5c) ..... ____
7. LESS PREVIOUS PAYMENTS (Line 6 of prior Application) ..... ____
8. AMOUNT DUE THIS APPLICATION ..... ____
9. BALANCE TO FINISH, PLUS RETAINAGE (Column G total on Progress Estimates + Line 5c above) ..... ____

CONTRACTOR'S CERTIFICATION

The undersigned Contractor certifies, to the best of its knowledge, the following:
(1) All previous progress payments received from Owner on account of Work done under the Contract have been applied on account to discharge Contractor's legitimate obligations incurred in connection with the Work covered by prior Applications for Payment;
(2) Title to all Work, materials and equipment incorporated in said Work, or otherwise listed in or covered by this Application for Payment, will pass to Owner at time of payment free and clear of all Liens, security interests, and encumbrances (except such as are covered by a bond acceptable to Owner indemnifying Owner against any such Liens, security interest, or encumbrances); and
(3) All the Work covered by this Application for Payment is in accordance with the Contract Documents and is not defective.

Contractor Signature

By		Date	

Payment of: ____
(Line 8 or or other - attach explaination of othe other amount)

is recommended by: ____ (Engineer) ____ (Date)

Payment of: ____
(Line 8 or or other - attach explaination of othe other amount)

is approved by: ____ (Engineer) ____ (Date)

Approved By: ____ (Funding or Financing Entity (if applicable) ____ (Date)

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SECTION 00 63 36
FIELD ORDER FORM

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Field Order No:

Project Name:	Date of Issuance:
Contract Name:	Effective Date:
Owner:	Owner's Contract No:
Contractor:	Contractor's Project No:
Engineer:	Engineer's Project No:

Contractor is hereby directed to promptly execute this Field Order, issued in accordance with General Conditions Paragraph 11.01, for minor changes in the Work without changes in Contract Price or Contract Times. If Contractor considers that a change in Contract Price or Contract Times is required, submit a Change Proposal before proceeding with this Work.

Reference: _____ _____
Specification(s) Drawing(s) / Detail(s)

Reason for Field Order:

Description of Change(s)

Attachments:

ISSUED:	RECEIVED:
By: _____	By: _____
Engineer (Authorized Signature)	Contractor (Authorized Signature)
Title:	Title:
Date:	Date:

Copy to: Owner

END OF SECTION

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SECTION 00 63 49
WORK CHANGE DIRECTIVE

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Work Change Directive

Date of Issuance:	Effective Date:
Owner:	Owner's Contract No.:
Contractor:	Contractor's Project No.:
Engineer:	Engineer's Project No.:
Project:	Contract Name:

Contractor is directed to proceed promptly with the following change(s):

Description:

Attachments: *[List documents supporting change]*

Purpose for Work Change Directive:

Directive to proceed promptly with the Work described herein, prior to agreeing to changes on Contract Price and Contract Time, is issued due to: *[check one or both of the following]*

☐ Non-agreement on pricing of proposed change.
☐ Necessity to proceed for schedule or other Project reasons.

Estimated Change in Contract Price and Contract Times (non-binding, preliminary):

Contract Price $ [increase] [decrease].
Contract Time days [increase] [decrease].

Basis of estimated change in Contract Price:

☐ Lump Sum ☐ Unit Price
☐ Cost of the Work ☐ Other

RECOMMENDED:	AUTHORIZED BY:	RECEIVED:
By:	By:	By:
Engineer (Authorized Signature)	Owner (Authorized Signature)	Contractor (Authorized Signature)
Title:	Title:	Title:
Date:	Date:	Date:

Approved by Funding Agency (if applicable)

By: _____ Date:

Title:

END OF SECTION

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SECTION 00 63 63
CHANGE ORDER

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Change Order No.

Date of Issuance:	Effective Date:
Owner:	Owner's Contract No.:
Contractor:	Contractor's Project No.:
Engineer:	Engineer's Project No.:
Project:	Contract Name:

The Contract is modified as follows upon execution of this Change Order:
Description:

Attachments: *[List documents supporting change]*

CHANGE IN CONTRACT PRICE	**CHANGE IN CONTRACT TIMES** *[note changes in Milestones if applicable]*
Original Contract Price: $	Original Contract Times: Substantial Completion: Ready for Final Payment: _____ days or dates
[increase] [decrease] from previously approved Change Orders No. ___ to No. ___: $	[increase] [decrease] from previously approved Change Orders No. ___ to No. ___: Substantial Completion: Ready for Final Payment: _____ days
Contract Price prior to this Change Order: $	Contract Times prior to this Change Order: Substantial Completion: Ready for Final Payment: _____ days or dates
[increase] [decrease] of this Change Order: $	[increase] [decrease] of this Change Order: Substantial Completion: Ready for Final Payment: _____ days or dates
Contract Price incorporating this Change Order: $	Contract Times with all approved Change Orders: Substantial Completion: Ready for Final Payment: _____ days or dates

RECOMMENDED:	ACCEPTED:	ACCEPTED:
By: _____	By: _____	By: _____
Engineer (if required)	Owner (Authorized)	Contractor (Authorized)
Title: _____	Title: _____	Title: _____
Date: _____	Date: _____	Date: _____

Approved by Funding Agency (if applicable)

By: _____ Date:

Title:

END OF SECTION

SECTION 00 65 16
CERTIFICATE OF SUBSTANTIAL COMPLETION

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Owner:	Owner's Contract No.:
Contractor:	Contractor's Project No.:
Engineer:	Engineer's Project No.:
Project:	Contract Name:

This [Select preliminary or final] Certificate of Substantial Completion applies to:

☐ All Work ☐ The following specified portions of the Work:

Date of Substantial Completion

The Work to which this Certificate applies has been inspected by authorized representatives of Owner, Contractor, and Engineer, and found to be substantially complete. The Date of Substantial Completion of the Work or portion thereof designated above is hereby established, subject to the provisions of the Contract pertaining to Substantial Completion. The date of Substantial Completion in the final Certificate of Substantial Completion marks the commencement of the contractual correction period and applicable warranties required by the Contract.

A punch list of items to be completed or corrected is attached to this Certificate. This list may not be all-inclusive, and the failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract.

The responsibilities between Owner and Contractor for security, operation, safety, maintenance, heat, utilities, insurance, and warranties upon Owner's use or occupancy of the Work shall be as provided in the Contract, except as amended as follows:

Amendments to Owner's responsibilities:
☐ None
☐ As follows

Amendments to Contractor's responsibilities:
☐ None
☐ As follows

The following documents are attached to and made a part of this Certificate: *(punch list; others)*

This Certificate does not constitute an acceptance of Work not in accordance with the Contract Documents, nor is it a release of Contractor's obligation to complete the Work in accordance with the Contract.

EXECUTED BY ENGINEER:	RECEIVED:	RECEIVED:
By: _____ (Authorized signature)	By: _____ Owner (Authorized Signature)	By: _____ Contractor (Authorized Signature)
Title: _____	Title: _____	Title: _____
Date: _____	Date: _____	Date: _____

END OF SECTION

SECTION 00 65 19
CONTRACTOR'S CERTIFICATE OF FINAL COMPLETION

TO:

FROM:

PROJECT: FISHER RANCH WATER TREATMENT PLANT

This is to certify that I, [_____], am an authorized official of [_____], working in the capacity of [_____] and have been properly authorized by said firm or corporation to sign the following statements pertaining to the subject Contract. I know of my own personal knowledge, and do hereby certify, that the Work of the Contract described above has been performed and all materials used and installed to date are in accordance with, and in conformity to, the Contract Documents.

The Work is now complete in all parts and requirements, excepting the attached list of minor deficiencies and the reasons for each being incomplete to date, for which exemption from final payment requirements is requested in conformance to Article 14.09A of the General Conditions (if no exemptions requested, write "none").

[_____]

The Work is now ready for your final inspection. The following items required from the Contractor prior to application for final payment (such as O & M Manuals, guarantees, record drawings, etc.) are submitted herewith, (If none, write “none”):

[_____]

I understand that neither the issuance by Engineer of a Notice of Completion, nor the acceptance thereof by Owner, shall operate as a bar of claim against Contractor under the terms of the guarantee provisions of the Contract Documents.

END OF SECTION

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SECTION 00 65 20
CONSENT OF SURETY FOR FINAL PAYMENT

PROJECT NAME: _____

LOCATION: _____

TYPE OF CONTRACT: _____

AMOUNT OF CONTRACT: _____

In accordance with the provisions of the above-named contract between the Owner and the Contractor, the following named Surety:

_____

_____

on the Payment Bond of the following named Contractor:

_____

_____

_____

hereby approves of final payment to the Contractor, and further agrees that said final payment to the Contractor shall not relieve the Surety of any of its obligations to the following named Owner (as set forth in said Surety's bond):

_____

_____

_____

IN WITNESS WHEREOF, the Surety has hereunto set its hand and seal this [_____] day of [_____] 20[_____].

_____
(Name of Surety)

_____
(Signature of Authorized Representative)

_____
(Name of Authorized Representative)

Title: _____

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SECTION 00 65 21
AFFIDAVIT OF PAYMENT

To All Whom It May Concern:

WHEREAS, the undersigned has been employed by the [_____] to furnish labor and materials under a contract dated [_____] 20[_____] for the project named "[_____]", in the [_____], of which [_____] is the Owner.

NOW, THEREFORE, this [_____] day of [_____], 20[_____], the undersigned, as the Contractor for the above-named Contract pursuant to the Conditions of the Contract hereby certifies that, except as listed below, he has paid in full or has otherwise satisfied all obligations for all materials and equipment furnished, for all work, labor, and services performed, and for all known indebtedness and claims against the Contractor for damages arising in any manner in connection with the performance of the Contract referenced above for which the Owner or his property might in any way be held responsible.

EXCEPTIONS: [_____]

(If none, write "None". If required by the Owner, the Contractor shall furnish bond satisfactory to the Owner for each exception.)

_____
Contractor

(Affix corporate seal here)

_____
(Signature of Authorized Representative)

Title: _____

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SECTION 00 70 00
GENERAL CONDITIONS

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ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Wherever used in the Bidding Requirements or Contract Documents, a term printed with initial capital letters, including the term's singular and plural forms, will have the meaning indicated in the definitions below. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.

2. *Agreement*—The written instrument, executed by Owner and Contractor, that sets forth the Contract Price and Contract Times, identifies the parties and the Engineer, and designates the specific items that are Contract Documents.

3. *Application for Payment*—The form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

4. *Bid*—The offer of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

5. *Bidder*—An individual or entity that submits a Bid to Owner.

6. *Bidding Documents*—The Bidding Requirements, the proposed Contract Documents, and all Addenda.

7. *Bidding Requirements*—The advertisement or invitation to bid, Instructions to Bidders, Bid Bond or other Bid security, if any, the Bid Form, and the Bid with any attachments.

8. *Change Order*—A document which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, or other revision to the Contract, issued on or after the Effective Date of the Contract.

9. *Change Proposal*—A written request by Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment in Contract Price or Contract Times, or both; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; challenging a set-off against payments due; or seeking other relief with respect to the terms of the Contract.

10. *Claim*—(a) A demand or assertion by Owner directly to Contractor, duly submitted in compliance with the procedural requirements set forth herein: seeking an adjustment of Contract Price or Contract Times, or both; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; contesting Engineer's decision regarding a Change Proposal; seeking resolution of a contractual issue that Engineer has declined to address; or seeking other relief with respect to the terms of the Contract; or (b) a demand or assertion by Contractor directly to Owner, duly submitted in compliance with the procedural requirements set forth herein, contesting Engineer's decision regarding a Change Proposal; or seeking resolution

of a contractual issue that Engineer has declined to address. A demand for money or services by a third party is not a Claim.

11. *Constituent of Concern*—Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to (a) the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. §§9601 et seq. ("CERCLA"); (b) the Hazardous Materials Transportation Act, 49 U.S.C. §§5501 et seq.; (c) the Resource Conservation and Recovery Act, 42 U.S.C. §§6901 et seq. ("RCRA"); (d) the Toxic Substances Control Act, 15 U.S.C. §§2601 et seq.; (e) the Clean Water Act, 33 U.S.C. §§1251 et seq.; (f) the Clean Air Act, 42 U.S.C. §§7401 et seq.; or (g) any other federal, state, or local statute, law, rule, regulation, ordinance, resolution, code, order, or decree regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.
12. *Contract*—The entire and integrated written contract between the Owner and Contractor concerning the Work.
13. *Contract Documents*—Those items so designated in the Agreement, and which together comprise the Contract.
14. *Contract Price*—The money that Owner has agreed to pay Contractor for completion of the Work in accordance with the Contract Documents. .
15. *Contract Times*—The number of days or the dates by which Contractor shall: (a) achieve Milestones, if any; (b) achieve Substantial Completion; and (c) complete the Work.
16. *Contractor*—The individual or entity with which Owner has contracted for performance of the Work.
17. *Cost of the Work*—See Paragraph 13.01 for definition.
18. *Drawings*—The part of the Contract that graphically shows the scope, extent, and character of the Work to be performed by Contractor.
19. *Effective Date of the Contract*—The date, indicated in the Agreement, on which the Contract becomes effective.
20. *Engineer*—The individual or entity named as such in the Agreement.
21. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but does not change the Contract Price or the Contract Times.
22. *Hazardous Environmental Condition*—The presence at the Site of Constituents of Concern in such quantities or circumstances that may present a danger to persons or property exposed thereto. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated in the Work, and that are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, does not establish a Hazardous Environmental Condition.
23. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, statutes, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

24. *Liens*—Charges, security interests, or encumbrances upon Contract-related funds, real property, or personal property.

25. *Milestone*—A principal event in the performance of the Work that the Contract requires Contractor to achieve by an intermediate completion date or by a time prior to Substantial Completion of all the Work.

26. *Notice of Award*—The written notice by Owner to a Bidder of Owner's acceptance of the Bid.

27. *Notice to Proceed*—A written notice by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work.

28. *Owner*—The individual or entity with which Contractor has contracted regarding the Work, and which has agreed to pay Contractor for the performance of the Work, pursuant to the terms of the Contract.

29. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor's plan to accomplish the Work within the Contract Times.

30. *Project*—The total undertaking to be accomplished for Owner by engineers, contractors, and others, including planning, study, design, construction, testing, commissioning, and start-up, and of which the Work to be performed under the Contract Documents is a part.

31. *Project Manual*—The written documents prepared for, or made available for, procuring and constructing the Work, including but not limited to the Bidding Documents or other construction procurement documents, geotechnical and existing conditions information, the Agreement, bond forms, General Conditions, Supplementary Conditions, and Specifications. The contents of the Project Manual may be bound in one or more volumes.

32. *Resident Project Representative*—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative or "RPR" includes any assistants or field staff of Resident Project Representative.

33. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and that establish the standards by which such portion of the Work will be judged.

34. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements for Engineer's review of the submittals and the performance of related construction activities.

35. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

36. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether approved or not, are not Drawings and are not Contract Documents.

37. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and

easements, and such other lands furnished by Owner which are designated for the use of Contractor.

38. *Specifications*—The part of the Contract that consists of written requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable to the Work.

39. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work.

40. *Substantial Completion*—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.

41. *Successful Bidder*—The Bidder whose Bid the Owner accepts, and to which the Owner makes an award of contract, subject to stated conditions.

42. *Supplementary Conditions*—The part of the Contract that amends or supplements these General Conditions.

43. *Supplier*—A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or a Subcontractor.

44. *Technical Data*—Those items expressly identified as Technical Data in the Supplementary Conditions, with respect to either (a) subsurface conditions at the Site, or physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities) or (b) Hazardous Environmental Conditions at the Site. If no such express identifications of Technical Data have been made with respect to conditions at the Site, then the data contained in boring logs, recorded measurements of subsurface water levels, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical or environmental report prepared for the Project and made available to Contractor are hereby defined as Technical Data with respect to conditions at the Site under Paragraphs 5.03, 5.04, and 5.06.

45. *Underground Facilities*—All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including but not limited to those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, fiber optic transmissions, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.

46. *Unit Price Work*—Work to be paid for on the basis of unit prices.

47. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction; furnishing, installing, and incorporating all materials

and equipment into such construction; and may include related services such as testing, start-up, and commissioning, all as required by the Contract Documents.

48. *Work Change Directive*—A written directive to Contractor issued on or after the Effective Date of the Contract, signed by Owner and recommended by Engineer, ordering an addition, deletion, or revision in the Work.

1.02 *Terminology*

A. The words and terms discussed in the following paragraphs are not defined but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. *Intent of Certain Terms or Adjectives*:

1. The Contract Documents include the terms "as allowed," "as approved," "as ordered," "as directed" or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory," or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Article 10 or any other provision of the Contract Documents.

C. *Day*:

1. The word "day" means a calendar day of 24 hours measured from midnight to the next midnight.

D. *Defective*:

1. The word "defective," when modifying the word "Work," refers to Work that is unsatisfactory, faulty, or deficient in that it:

a. does not conform to the Contract Documents; or

b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or

c. has been damaged prior to Engineer's recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 15.03 or 15.04).

E. *Furnish, Install, Perform, Provide*:

1. The word "furnish," when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.

2. The word "install," when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.

3. The words "perform" or "provide," when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.

4. If the Contract Documents establish an obligation of Contractor with respect to specific services, materials, or equipment, but do not expressly use any of the four words "furnish," "install," "perform," or "provide," then Contractor shall furnish and install said services, materials, or equipment complete and ready for intended use.

F. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 – PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

A. *Bonds*: When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.

B. *Evidence of Contractor's Insurance*: When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner, with copies to each named insured and additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract), the certificates and other evidence of insurance required to be provided by Contractor in accordance with Article 6.

C. *Evidence of Owner's Insurance*: After receipt of the executed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor, with copies to each named insured and additional insured (as identified in the Supplementary Conditions or otherwise), the certificates and other evidence of insurance required to be provided by Owner under Article 6.

2.02 *Copies of Documents*

A. Owner shall furnish to Contractor four printed copies of the Contract (including one fully executed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.

B. Owner shall maintain and safeguard at least one original printed record version of the Contract, including Drawings and Specifications signed and sealed by Engineer and other design professionals. Owner shall make such original printed record version of the Contract available to Contractor for review. Owner may delegate the responsibilities under this provision to Engineer.

2.03 *Before Starting Construction*

A. *Preliminary Schedules*: Within 10 days after the Effective Date of the Contract (or as otherwise specifically required by the Contract Documents), Contractor shall submit to Engineer for timely review:

1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract;

2. a preliminary Schedule of Submittals; and

3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.04 *Preconstruction Conference; Designation of Authorized Representatives*

A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.03.A, procedures for handling Shop Drawings, Samples, and other submittals, processing Applications for Payment, electronic or digital transmittals, and maintaining required records.

B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.05 *Initial Acceptance of Schedules*

A. At least 10 days before submission of the first Application for Payment a conference, attended by Contractor, Engineer, and others as appropriate, will be held to review for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.03.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be made to Contractor until acceptable schedules are submitted to Engineer.

1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.

2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.

3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to the component parts of the Work.

2.06 *Electronic Transmittals*

A. Except as otherwise stated elsewhere in the Contract, the Owner, Engineer, and Contractor may transmit, and shall accept, Project-related correspondence, text, data, documents, drawings, information, and graphics, including but not limited to Shop Drawings and other submittals, in electronic media or digital format, either directly, or through access to a secure Project website.

B. If the Contract does not establish protocols for electronic or digital transmittals, then Owner, Engineer, and Contractor shall jointly develop such protocols.

C. When transmitting items in electronic media or digital format, the transmitting party makes no representations as to long term compatibility, usability, or readability of the items resulting from the recipient's use of software application packages, operating

systems, or computer hardware differing from those used in the drafting or transmittal of the items, or from those established in applicable transmittal protocols.

ARTICLE 3 – DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 *Intent*

A. The Contract Documents are complementary; what is required by one is as binding as if required by all.

B. It is the intent of the Contract Documents to describe a functionally complete project (or part thereof) to be constructed in accordance with the Contract Documents.

C. Unless otherwise stated in the Contract Documents, if there is a discrepancy between the electronic or digital versions of the Contract Documents (including any printed copies derived from such electronic or digital versions) and the printed record version, the printed record version shall govern.

D. The Contract supersedes prior negotiations, representations, and agreements, whether written or oral.

E. Engineer will issue clarifications and interpretations of the Contract Documents as provided herein.

3.02 *Reference Standards*

A. Standards Specifications, Codes, Laws and Regulations

1. Reference in the Contract Documents to standard specifications, manuals, reference standards, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard specification, manual, reference standard, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Contract if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

2. No provision of any such standard specification, manual, reference standard, or code, or any instruction of a Supplier, shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees, from those set forth in the part of the Contract Documents prepared by or for Engineer. No such provision or instruction shall be effective to assign to Owner, Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the part of the Contract Documents prepared by or for Engineer.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies*:

1. *Contractor's Verification of Figures and Field Measurements*: Before undertaking each part of the Work, Contractor shall carefully study the Contract Documents, and check and verify pertinent figures and dimensions therein, particularly with respect to applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy that Contractor discovers, or has actual knowledge of, and shall not proceed with any Work affected thereby until

the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract Documents issued pursuant to Paragraph 11.01.

2. *Contractor's Review of Contract Documents*: If, before or during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation, (b) actual field conditions, (c) any standard specification, manual, reference standard, or code, or (d) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 7.15) until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract Documents issued pursuant to Paragraph 11.01.

3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. *Resolving Discrepancies*:

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the part of the Contract Documents prepared by or for Engineer shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between such provisions of the Contract Documents and:

a. the provisions of any standard specification, manual, reference standard, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference as a Contract Document); or

b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Requirements of the Contract Documents*

A. During the performance of the Work and until final payment, Contractor and Owner shall submit to the Engineer all matters in question concerning the requirements of the Contract Documents (sometimes referred to as requests for information or interpretation—RFIs), or relating to the acceptability of the Work under the Contract Documents, as soon as possible after such matters arise. Engineer will be the initial interpreter of the requirements of the Contract Documents, and judge of the acceptability of the Work thereunder.

B. Engineer will, with reasonable promptness, render a written clarification, interpretation, or decision on the issue submitted, or initiate an amendment or supplement to the Contract Documents. Engineer's written clarification, interpretation, or decision will be final and binding on Contractor, unless it appeals by submitting a Change Proposal, and on Owner, unless it appeals by filing a Claim.

C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work under the Contract Documents, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly give written notice to Owner and Contractor that Engineer is unable to provide a decision

or interpretation. If Owner and Contractor are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in Article 12.

3.05 *Reuse of Documents*

A. Contractor and its Subcontractors and Suppliers shall not:

1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media editions, or reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer; or

2. have or acquire any title or ownership rights in any other Contract Documents, reuse any such Contract Documents for any purpose without Owner's express written consent, or violate any copyrights pertaining to such Contract Documents.

B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

ARTICLE 4 – COMMENCEMENT AND PROGRESS OF THE WORK

4.01 *Commencement of Contract Times; Notice to Proceed*

A. The Contract Times will commence to run on the thirtieth day after the Effective Date of the Contract or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Contract. In no event will the Contract Times commence to run later than the sixtieth day after the day of Bid opening or the thirtieth day after the Effective Date of the Contract, whichever date is earlier.

4.02 *Starting the Work*

A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work shall be done at the Site prior to such date.

4.03 *Reference Points*

A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.04 *Progress Schedule*

A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.05 as it may be adjusted from time to time as provided below.

1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.05) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times.

2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 11.

B. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, or during any appeal process, except as permitted by Paragraph 16.04, or as Owner and Contractor may otherwise agree in writing.

4.05 *Delays in Contractor's Progress*

A. If Owner, Engineer, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Times and Contract Price. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.

B. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of Contractor. Delay, disruption, and interference attributable to and within the control of a Subcontractor or Supplier shall be deemed to be within the control of Contractor.

C. If Contractor's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Owner, Contractor, and those for which they are responsible, then Contractor shall be entitled to an equitable adjustment in Contract Times. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. Causes of delay, disruption, or interference that may give rise to an adjustment in Contract Times under this paragraph include but are not limited to the following:

1. severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;

2. abnormal weather conditions;

3. acts or failures to act of utility owners (other than those performing other work at or adjacent to the Site by arrangement with the Owner, as contemplated in Article 8); and

4. acts of war or terrorism.

D. Delays, disruption, and interference to the performance or progress of the Work resulting from the existence of a differing subsurface or physical condition, an Underground Facility that was not shown or indicated by the Contract Documents, or not shown or indicated with reasonable accuracy, and those resulting from Hazardous Environmental Conditions, are governed by Article 5.

E. Paragraph 8.03 governs delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site.

F. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of Contractor.

G. Contractor must submit any Change Proposal seeking an adjustment in Contract Price or Contract Times under this paragraph within 30 days of the commencement of the delaying, disrupting, or interfering event.

ARTICLE 5 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

5.01 *Availability of Lands*

A. Owner shall furnish the Site. Owner shall notify Contractor of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work.

B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which permanent improvements are to be made and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.

C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

5.02 *Use of Site and Other Areas*

A. *Limitation on Use of Site and Other Areas*:

1. Contractor shall confine construction equipment, temporary construction facilities, the storage of materials and equipment, and the operations of workers to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and such other adjacent areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for (a) damage to the Site; (b) damage to any such other adjacent areas used for Contractor's operations; (c) damage to any other adjacent land or areas; and (d) for injuries and losses sustained by the owners or occupants of any such land or areas; provided that such damage or injuries result from the performance of the Work or from other actions or conduct of the Contractor or those for which Contractor is responsible.

2. If a damage or injury claim is made by the owner or occupant of any such land or area because of the performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible, Contractor shall (a) take immediate corrective or remedial action as required by Paragraph 7.12, or otherwise; (b) promptly attempt to settle the claim as to all parties through negotiations with such owner or occupant, or otherwise resolve the claim by arbitration or other dispute resolution proceeding, or at law; and (c) to the fullest extent permitted by Laws and Regulations, indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against any such claim, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court

or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused directly or indirectly, in whole or in part by, or based upon, Contractor's performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible.

B. *Removal of Debris During Performance of the Work*: During the progress of the Work the Contractor shall keep the Site and other adjacent areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.

C. *Cleaning*: Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site and adjacent areas all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

D. *Loading of Structures*: Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent structures or land to stresses or pressures that will endanger them.

5.03 *Subsurface and Physical Conditions*

A. *Reports and Drawings*: The Supplementary Conditions identify:

1. those reports known to Owner of explorations and tests of subsurface conditions at or adjacent to the Site;

2. those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities); and

3. Technical Data contained in such reports and drawings.

B. *Reliance by Contractor on Technical Data Authorized*: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely upon the accuracy of the Technical Data (as defined in Article 1) contained in any geotechnical or environmental report prepared for the Project and made available to Contractor. Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions, or information.

5.04 *Differing Subsurface or Physical Conditions*

A. *Notice by Contractor*: If Contractor believes that any subsurface or physical condition that is uncovered or revealed at the Site either:

1. is of such a nature as to establish that any Technical Data on which Contractor is entitled to rely as provided in Paragraph 5.03 is materially inaccurate; or

2. is of such a nature as to require a change in the Drawings or Specifications; or

3. differs materially from that shown or indicated in the Contract Documents; or

4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except with respect to an emergency) until receipt of a written statement permitting Contractor to do so.

B. *Engineer's Review*: After receipt of written notice as required by the preceding paragraph, Engineer will promptly review the subsurface or physical condition in question; determine the necessity of Owner's obtaining additional exploration or tests with respect to the condition; conclude whether the condition falls within any one or more of the differing site condition categories in Paragraph 5.04.A above; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the subsurface or physical condition in question and the need for any change in the Drawings or Specifications; and advise Owner in writing of Engineer's findings, conclusions, and recommendations.

C. *Owner's Statement to Contractor Regarding Site Condition*: After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the subsurface or physical condition in question, addressing the resumption of Work in connection with such condition, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations, in whole or in part.

D. *Possible Price and Times Adjustments*:

1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, or both, to the extent that the existence of a differing subsurface or physical condition, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

a. such condition must fall within any one or more of the categories described in Paragraph 5.04.A;

b. with respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03; and,

c. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.

2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:

a. Contractor knew of the existence of such condition at the time Contractor made a commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract, or otherwise; or

b. the existence of such condition reasonably could have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas expressly required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such commitment; or

c. Contractor failed to give the written notice as required by Paragraph 5.04.A.

3. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, or both, then any such adjustment shall be set forth in a Change Order.

4. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, or both, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the subsurface or physical condition in question.

5.05 *Underground Facilities*

A. *Contractor's Responsibilities*: The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or adjacent to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

1. Owner and Engineer do not warrant or guarantee the accuracy or completeness of any such information or data provided by others; and

2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:

a. reviewing and checking all information and data regarding existing Underground Facilities at the Site;

b. locating all Underground Facilities shown or indicated in the Contract Documents as being at the Site;

c. coordination of the Work with the owners (including Owner) of such Underground Facilities, during construction; and

d. the safety and protection of all existing Underground Facilities at the Site, and repairing any damage thereto resulting from the Work.

B. *Notice by Contractor*: If Contractor believes that an Underground Facility that is uncovered or revealed at the Site was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy, then Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby

or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer.

C. *Engineer's Review*: Engineer will promptly review the Underground Facility and conclude whether such Underground Facility was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the Underground Facility in question; determine the extent, if any, to which a change is required in the Drawings or Specifications to reflect and document the consequences of the existence or location of the Underground Facility; and advise Owner in writing of Engineer's findings, conclusions, and recommendations. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

D. *Owner's Statement to Contractor Regarding Underground Facility*: After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the Underground Facility in question, addressing the resumption of Work in connection with such Underground Facility, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations in whole or in part.

E. *Possible Price and Times Adjustments*:

1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, or both, to the extent that any existing Underground Facility at the Site that was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

    a. Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated the existence or actual location of the Underground Facility in question;

    b. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03;

    c. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times; and

    d. Contractor gave the notice required in Paragraph 5.05.B.

2. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, or both, then any such adjustment shall be set forth in a Change Order.

3. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, or both, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the Underground Facility in question.

5.06 *Hazardous Environmental Conditions at Site*

A. *Reports and Drawings*: The Supplementary Conditions identify:

1. those reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and

2. Technical Data contained in such reports and drawings.

B. *Reliance by Contractor on Technical Data Authorized*: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely on the accuracy of the Technical Data (as defined in Article 1) contained in any geotechnical or environmental report prepared for the Project and made available to Contractor. Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions or information.

C. Contractor shall not be responsible for removing or remediating any Hazardous Environmental Condition encountered, uncovered, or revealed at the Site unless such removal or remediation is expressly identified in the Contract Documents to be within the scope of the Work.

D. Contractor shall be responsible for controlling, containing, and duly removing all Constituents of Concern brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible, and for any associated costs; and for the costs of removing and remediating any Hazardous Environmental Condition created by the presence of any such Constituents of Concern.

E. If Contractor encounters, uncovers, or reveals a Hazardous Environmental Condition whose removal or remediation is not expressly identified in the Contract Documents as being within the scope of the Work, or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, then Contractor shall immediately: (1) secure or otherwise isolate such condition; (2) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 7.15); and (3) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 5.06.F. If Contractor or anyone for whom Contractor is responsible created the Hazardous Environmental Condition in question, then Owner may remove and

remediate the Hazardous Environmental Condition, and impose a set-off against payments to account for the associated costs.

F. Contractor shall not resume Work in connection with such Hazardous Environmental Condition or in any affected area until after Owner has obtained any required permits related thereto, and delivered written notice to Contractor either (1) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or (2) specifying any special conditions under which such Work may be resumed safely.

G. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, then within 30 days of Owner's written notice regarding the resumption of Work, Contractor may submit a Change Proposal, or Owner may impose a set-off.

H. If after receipt of such written notice Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work, following the contractual change procedures in Article 11. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 8.

I. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition (1) was not shown or indicated in the Drawings, Specifications, or other Contract Documents, identified as Technical Data entitled to limited reliance pursuant to Paragraph 5.06.B, or identified in the Contract Documents to be included within the scope of the Work, and (2) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.H shall obligate Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

J. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the failure to control, contain, or remove a Constituent of Concern brought to the Site by Contractor or by anyone for whom Contractor is responsible, or to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.J shall obligate Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

K. The provisions of Paragraphs 5.03, 5.04, and 5.05 do not apply to the presence of Constituents of Concern or to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 6 – BONDS AND INSURANCE

6.01 *Performance, Payment, and Other Bonds*

A. Contractor shall furnish a performance bond and a payment bond, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of all of Contractor's obligations under the Contract. These bonds shall remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 15.08, whichever is later, except as provided otherwise by Laws or Regulations, the Supplementary Conditions, or other specific provisions of the Contract. Contractor shall also furnish such other bonds as are required by the Supplementary Conditions or other specific provisions of the Contract.

B. All bonds shall be in the form prescribed by the Contract except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (as amended and supplemented) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. A bond signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority shall show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.

C. Contractor shall obtain the required bonds from surety companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds in the required amounts.

D. If the surety on a bond furnished by Contractor is declared bankrupt or becomes insolvent, or its right to do business is terminated in any state or jurisdiction where any part of the Project is located, or the surety ceases to meet the requirements above, then Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the bond and surety requirements above.

E. If Contractor has failed to obtain a required bond, Owner may exclude the Contractor from the Site and exercise Owner's termination rights under Article 16.

F. Upon request, Owner shall provide a copy of the payment bond to any Subcontractor, Supplier, or other person or entity claiming to have furnished labor or materials used in the performance of the Work.

6.02 *Insurance—General Provisions*

A. Owner and Contractor shall obtain and maintain insurance as required in this Article and in the Supplementary Conditions.

B. All insurance required by the Contract to be purchased and maintained by Owner or Contractor shall be obtained from insurance companies that are duly licensed or authorized, in the state or jurisdiction in which the Project is located, to issue insurance policies for the required limits and coverages. Unless a different standard is indicated in the Supplementary Conditions, all companies that provide insurance policies required under this Contract shall have an A.M. Best rating of A-VII or better.

C. Contractor shall deliver to Owner, with copies to each named insured and additional insured (as identified in this Article, in the Supplementary Conditions, or elsewhere in the Contract), certificates of insurance establishing that Contractor has obtained and is

maintaining the policies, coverages, and endorsements required by the Contract. Upon request by Owner or any other insured, Contractor shall also furnish other evidence of such required insurance, including but not limited to copies of policies and endorsements, and documentation of applicable self-insured retentions and deductibles. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

D. Owner shall deliver to Contractor, with copies to each named insured and additional insured (as identified in this Article, the Supplementary Conditions, or elsewhere in the Contract), certificates of insurance establishing that Owner has obtained and is maintaining the policies, coverages, and endorsements required of Owner by the Contract (if any). Upon request by Contractor or any other insured, Owner shall also provide other evidence of such required insurance (if any), including but not limited to copies of policies and endorsements, and documentation of applicable self-insured retentions and deductibles. Owner may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

E. Failure of Owner or Contractor to demand such certificates or other evidence of the other party's full compliance with these insurance requirements, or failure of Owner or Contractor to identify a deficiency in compliance from the evidence provided, shall not be construed as a waiver of the other party's obligation to obtain and maintain such insurance.

F. If either party does not purchase or maintain all of the insurance required of such party by the Contract, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage.

G. If Contractor has failed to obtain and maintain required insurance, Owner may exclude the Contractor from the Site, impose an appropriate set-off against payment, and exercise Owner's termination rights under Article 16.

H. Without prejudice to any other right or remedy, if a party has failed to obtain required insurance, the other party may elect to obtain equivalent insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and the Contract Price shall be adjusted accordingly.

I. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor's interests.

J. The insurance and insurance limits required herein shall not be deemed as a limitation on Contractor's liability under the indemnities granted to Owner and other individuals and entities in the Contract.

6.03 *Contractor's Insurance*

A. *Workers' Compensation*: Contractor shall purchase and maintain workers' compensation and employer's liability insurance for:

1. claims under workers' compensation, disability benefits, and other similar employee benefit acts.

2. United States Longshoreman and Harbor Workers' Compensation Act and Jones Act coverage (if applicable).

3. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees (by stop-gap endorsement in monopolist worker's compensation states).

4. Foreign voluntary worker compensation (if applicable).

B. *Commercial General Liability—Claims Covered*: Contractor shall purchase and maintain commercial general liability insurance, covering all operations by or on behalf of Contractor, on an occurrence basis, against:

1. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees.

2. claims for damages insured by reasonably available personal injury liability coverage.

3. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom.

C. *Commercial General Liability—Form and Content*: Contractor's commercial liability policy shall be written on a 1996 (or later) ISO commercial general liability form (occurrence form) and include the following coverages and endorsements:

1. Products and completed operations coverage:

a. Such insurance shall be maintained for three years after final payment.

b. Contractor shall furnish Owner and each other additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract) evidence of continuation of such insurance at final payment and three years thereafter.

2. Blanket contractual liability coverage, to the extent permitted by law, including but not limited to coverage of Contractor's contractual indemnity obligations in Paragraph 7.18.

3. Broad form property damage coverage.

4. Severability of interest.

5. Underground, explosion, and collapse coverage.

6. Personal injury coverage.

7. Additional insured endorsements that include both ongoing operations and products and completed operations coverage through ISO Endorsements CG 20 10 10 01 and CG 20 37 10 01 (together); or CG 20 10 07 04 and CG 20 37 07 04 (together); or their equivalent.

8. For design professional additional insureds, ISO Endorsement CG 20 32 07 04, "Additional Insured—Engineers, Architects or Surveyors Not Engaged by the Named Insured" or its equivalent.

D. *Automobile liability*: Contractor shall purchase and maintain automobile liability insurance against claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance, or use of any motor vehicle. The automobile liability policy shall be written on an occurrence basis.

E. *Umbrella or excess liability*: Contractor shall purchase and maintain umbrella or excess liability insurance written over the underlying employer's liability, commercial general liability, and automobile liability insurance described in the paragraphs above. Subject

to industry-standard exclusions, the coverage afforded shall follow form as to each and every one of the underlying policies.

F. *Contractor's pollution liability insurance*: Contractor shall purchase and maintain a policy covering third-party injury and property damage claims, including clean-up costs, as a result of pollution conditions arising from Contractor's operations and completed operations. This insurance shall be maintained for no less than three years after final completion.

G. *Additional insureds*: The Contractor's commercial general liability, automobile liability, umbrella or excess, and pollution liability policies shall include and list as additional insureds Owner and Engineer, and any individuals or entities identified in the Supplementary Conditions; include coverage for the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of all such additional insureds; and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby (including as applicable those arising from both ongoing and completed operations) on a non-contributory basis. Contractor shall obtain all necessary endorsements to support these requirements.

H. *Contractor's professional liability insurance*: If Contractor will provide or furnish professional services under this Contract, through a delegation of professional design services or otherwise, then Contractor shall be responsible for purchasing and maintaining applicable professional liability insurance. This insurance shall provide protection against claims arising out of performance of professional design or related services, and caused by a negligent error, omission, or act for which the insured party is legally liable. It shall be maintained throughout the duration of the Contract and for a minimum of two years after Substantial Completion. If such professional design services are performed by a Subcontractor, and not by Contractor itself, then the requirements of this paragraph may be satisfied through the purchasing and maintenance of such insurance by such Subcontractor.

I. *General provisions*: The policies of insurance required by this Paragraph 6.03 shall:

1. include at least the specific coverages provided in this Article.

2. be written for not less than the limits of liability provided in this Article and in the Supplementary Conditions, or required by Laws or Regulations, whichever is greater.

3. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed, or renewal refused until at least 10 days prior written notice has been given to Contractor. Within three days of receipt of any such written notice, Contractor shall provide a copy of the notice to Owner, Engineer, and each other insured under the policy.

4. remain in effect at least until final payment (and longer if expressly required in this Article) and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work as a warranty or correction obligation, or otherwise, or returning to the Site to conduct other tasks arising from the Contract Documents.

5. be appropriate for the Work being performed and provide protection from claims that may arise out of or result from Contractor's performance of the Work and Contractor's other obligations under the Contract Documents, whether it is to be performed by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable.

J. The coverage requirements for specific policies of insurance must be met by such policies, and not by reference to excess or umbrella insurance provided in other policies.

6.04 *Owner's Liability Insurance*

A. In addition to the insurance required to be provided by Contractor under Paragraph 6.03, Owner, at Owner's option, may purchase and maintain at Owner's expense Owner's own liability insurance as will protect Owner against claims which may arise from operations under the Contract Documents.

B. Owner's liability policies, if any, operate separately and independently from policies required to be provided by Contractor, and Contractor cannot rely upon Owner's liability policies for any of Contractor's obligations to the Owner, Engineer, or third parties.

6.05 *Property Insurance*

A. *Builder's Risk*: Unless otherwise provided in the Supplementary Conditions, Contractor shall purchase and maintain builder's risk insurance upon the Work on a completed value basis, in the amount of the full insurable replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:

1. include the Owner and Contractor as named insureds, and all Subcontractors, and any individuals or entities required by the Supplementary Conditions to be insured under such builder's risk policy, as insureds or named insureds. For purposes of the remainder of this Paragraph 6.05, Paragraphs 6.06 and 6.07, and any corresponding Supplementary Conditions, the parties required to be insured shall collectively be referred to as "insureds."

2. be written on a builder's risk "all risk" policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire; lightning; windstorm; riot; civil commotion; terrorism; vehicle impact; aircraft; smoke; theft; vandalism and malicious mischief; mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake; volcanic activity, and other earth movement; flood; collapse; explosion; debris removal; demolition occasioned by enforcement of Laws and Regulations; water damage (other than that caused by flood); and such other perils or causes of loss as may be specifically required by the Supplementary Conditions. If insurance against mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake; volcanic activity, and other earth movement; or flood, are not commercially available under builder's risk policies, by endorsement or otherwise, such insurance may be provided through other insurance policies acceptable to Owner and Contractor.

3. cover, as insured property, at least the following: (a) the Work and all materials, supplies, machinery, apparatus, equipment, fixtures, and other property of a similar nature that are to be incorporated into or used in the preparation, fabrication, construction, erection, or completion of the Work, including Owner-furnished or assigned property; (b) spare parts inventory required within the scope of the Contract; and (c) temporary works which are not intended to form part of the permanent constructed Work but which are intended to provide working access to the Site, or to the Work under construction, or which are intended to provide temporary support for the Work under construction, including scaffolding, form work, fences, shoring, falsework, and temporary structures.

4. cover expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects).
5. extend to cover damage or loss to insured property while in temporary storage at the Site or in a storage location outside the Site (but not including property stored at the premises of a manufacturer or Supplier).
6. extend to cover damage or loss to insured property while in transit.
7. allow for partial occupation or use of the Work by Owner, such that those portions of the Work that are not yet occupied or used by Owner shall remain covered by the builder's risk insurance.
8. allow for the waiver of the insurer's subrogation rights, as set forth below.
9. provide primary coverage for all losses and damages caused by the perils or causes of loss covered.
10. not include a co-insurance clause.
11. include an exception for ensuing losses from physical damage or loss with respect to any defective workmanship, design, or materials exclusions.
12. include performance/hot testing and start-up.
13. be maintained in effect, subject to the provisions herein regarding Substantial Completion and partial occupancy or use of the Work by Owner, until the Work is complete.

B. *Notice of Cancellation or Change*: All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this Paragraph 6.05 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 10 days prior written notice has been given to the purchasing policyholder. Within three days of receipt of any such written notice, the purchasing policyholder shall provide a copy of the notice to each other insured.

C. *Deductibles*: The purchaser of any required builder's risk or property insurance shall pay for costs not covered because of the application of a policy deductible.

D. *Partial Occupancy or Use by Owner*: If Owner will occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 15.04, then Owner (directly, if it is the purchaser of the builder's risk policy, or through Contractor) will provide notice of such occupancy or use to the builder's risk insurer. The builder's risk insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy; rather, those portions of the Work that are occupied or used by Owner may come off the builder's risk policy, while those portions of the Work not yet occupied or used by Owner shall remain covered by the builder's risk insurance.

E. *Additional Insurance*: If Contractor elects to obtain other special insurance to be included in or supplement the builder's risk or property insurance policies provided under this Paragraph 6.05, it may do so at Contractor's expense.

F. *Insurance of Other Property*: If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, such as tools, construction equipment, or other personal property owned by Contractor, a Subcontractor, or an employee of Contractor or a Subcontractor, then the entity or

individual owning such property item will be responsible for deciding whether to insure it, and if so in what amount.

6.06 *Waiver of Rights*

A. All policies purchased in accordance with Paragraph 6.05, expressly including the builder's risk policy, shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any insureds thereunder, or against Engineer or its consultants, or their officers, directors, members, partners, employees, agents, consultants, or subcontractors. Owner and Contractor waive all rights against each other and the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Engineer, its consultants, all Subcontractors, all individuals or entities identified in the Supplementary Conditions as insureds, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner or Contractor as trustee or fiduciary, or otherwise payable under any policy so issued.

B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, for:

1. loss due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other perils whether or not insured by Owner; and

2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner during partial occupancy or use pursuant to Paragraph 15.04, after Substantial Completion pursuant to Paragraph 15.03, or after final payment pursuant to Paragraph 15.06.

C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 6.06.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery against Contractor, Subcontractors, or Engineer, or the officers, directors, members, partners, employees, agents, consultants, or subcontractors of each and any of them.

D. Contractor shall be responsible for assuring that the agreement under which a Subcontractor performs a portion of the Work contains provisions whereby the Subcontractor waives all rights against Owner, Contractor, all individuals or entities identified in the Supplementary Conditions as insureds, the Engineer and its consultants, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by builder's risk insurance and any other property insurance applicable to the Work.

6.07 *Receipt and Application of Property Insurance Proceeds*

A. Any insured loss under the builder's risk and other policies of insurance required by Paragraph 6.05 will be adjusted and settled with the named insured that purchased the policy. Such named insured shall act as fiduciary for the other insureds, and give notice to such other insureds that adjustment and settlement of a claim is in progress. Any other insured may state its position regarding a claim for insured loss in writing within 15 days after notice of such claim.

B. Proceeds for such insured losses may be made payable by the insurer either jointly to multiple insureds, or to the named insured that purchased the policy in its own right and as fiduciary for other insureds, subject to the requirements of any applicable mortgage clause. A named insured receiving insurance proceeds under the builder's risk and other policies of insurance required by Paragraph 6.05 shall distribute such proceeds in accordance with such agreement as the parties in interest may reach, or as otherwise required under the dispute resolution provisions of this Contract or applicable Laws and Regulations.

C. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the money so received applied on account thereof, and the Work and the cost thereof covered by Change Order, if needed.

ARTICLE 7 – CONTRACTOR'S RESPONSIBILITIES

7.01 *Supervision and Superintendence*

A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.

B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

7.02 *Labor; Working Hours*

A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall at all times maintain good discipline and order at the Site.

B. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours, Monday through Friday. Contractor will not perform Work on a Saturday, Sunday, or any legal holiday. Contractor may perform Work outside regular working hours or on Saturdays, Sundays, or legal holidays only with Owner's written consent, which will not be unreasonably withheld.

7.03 *Services, Materials, and Equipment*

A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and

incidentals necessary for the performance, testing, start up, and completion of the Work, whether or not such items are specifically called for in the Contract Documents.

B. All materials and equipment incorporated into the Work shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.

C. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

7.04 *"Or Equals"*

A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the Contract Price has been based upon Contractor furnishing such item as specified. The specification or description of such an item is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or equal" item is permitted, Contractor may request that Engineer authorize the use of other items of material or equipment, or items from other proposed suppliers under the circumstances described below.

1. If Engineer in its sole discretion determines that an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, Engineer shall deem it an "or equal" item. For the purposes of this paragraph, a proposed item of material or equipment will be considered functionally equal to an item so named if:

a. in the exercise of reasonable judgment Engineer determines that:

1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole;

3) it has a proven record of performance and availability of responsive service; and

4) it is not objectionable to Owner.

b. Contractor certifies that, if approved and incorporated into the Work:

1) there will be no increase in cost to the Owner or increase in Contract Times; and

2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.

B. *Contractor's Expense*: Contractor shall provide all data in support of any proposed "or equal" item at Contractor's expense.

C. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each "or-equal" request. Engineer may require Contractor to furnish additional data about the proposed "or-equal" item. Engineer will be the sole judge of acceptability.

No "or-equal" item will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an "or-equal", which will be evidenced by an approved Shop Drawing or other written communication. Engineer will advise Contractor in writing of any negative determination.

D. *Effect of Engineer's Determination*: Neither approval nor denial of an "or-equal" request shall result in any change in Contract Price. The Engineer's denial of an "or-equal" request shall be final and binding, and may not be reversed through an appeal under any provision of the Contract Documents.

E. *Treatment as a Substitution Request*: If Engineer determines that an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item, Contractor may request that Engineer considered the proposed item as a substitute pursuant to Paragraph 7.05.

7.05 *Substitutes*

A. Unless the specification or description of an item of material or equipment required to be furnished under the Contract Documents contains or is followed by words reading that no substitution is permitted, Contractor may request that Engineer authorize the use of other items of material or equipment under the circumstances described below. To the extent possible such requests shall be made before commencement of related construction at the Site.

1. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is functionally equivalent to that named and an acceptable substitute therefor. Engineer will not accept requests for review of proposed substitute items of material or equipment from anyone other than Contractor.

2. The requirements for review by Engineer will be as set forth in Paragraph 7.05.B, as supplemented by the Specifications, and as Engineer may decide is appropriate under the circumstances.

3. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:

a. shall certify that the proposed substitute item will:

1) perform adequately the functions and achieve the results called for by the general design,

2) be similar in substance to that specified, and

3) be suited to the same use as that specified.

b. will state:

1) the extent, if any, to which the use of the proposed substitute item will necessitate a change in Contract Times,

2) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item, and

3) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty.

c. will identify:

1) all variations of the proposed substitute item from that specified, and

2) available engineering, sales, maintenance, repair, and replacement services.

d. shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including but not limited to changes in Contract Price, shared savings, costs of redesign, and claims of other contractors affected by any resulting change.

B. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each substitute request, and to obtain comments and direction from Owner. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No substitute will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an acceptable substitute. Engineer's determination will be evidenced by a Field Order or a proposed Change Order accounting for the substitution itself and all related impacts, including changes in Contract Price or Contract Times. Engineer will advise Contractor in writing of any negative determination.

C. *Special Guarantee*: Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.

D. *Reimbursement of Engineer's Cost*: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

E. *Contractor's Expense*: Contractor shall provide all data in support of any proposed substitute at Contractor's expense.

F. *Effect of Engineer's Determination*: If Engineer approves the substitution request, Contractor shall execute the proposed Change Order and proceed with the substitution. The Engineer's denial of a substitution request shall be final and binding, and may not be reversed through an appeal under any provision of the Contract Documents. Contractor may challenge the scope of reimbursement costs imposed under Paragraph 7.05.D, by timely submittal of a Change Proposal.

7.06 *Concerning Subcontractors, Suppliers, and Others*

A. Contractor may retain Subcontractors and Suppliers for the performance of parts of the Work. Such Subcontractors and Suppliers must be acceptable to Owner.

B. Contractor shall retain specific Subcontractors, Suppliers, or other individuals or entities for the performance of designated parts of the Work if required by the Contract to do so.

C. Subsequent to the submittal of Contractor's Bid or final negotiation of the terms of the Contract, Owner may not require Contractor to retain any Subcontractor, Supplier, or

other individual or entity to furnish or perform any of the Work against which Contractor has reasonable objection.

D. Prior to entry into any binding subcontract or purchase order, Contractor shall submit to Owner the identity of the proposed Subcontractor or Supplier (unless Owner has already deemed such proposed Subcontractor or Supplier acceptable, during the bidding process or otherwise). Such proposed Subcontractor or Supplier shall be deemed acceptable to Owner unless Owner raises a substantive, reasonable objection within five days.

E. Owner may require the replacement of any Subcontractor, Supplier, or other individual or entity retained by Contractor to perform any part of the Work. Owner also may require Contractor to retain specific replacements; provided, however, that Owner may not require a replacement to which Contractor has a reasonable objection. If Contractor has submitted the identity of certain Subcontractors, Suppliers, or other individuals or entities for acceptance by Owner, and Owner has accepted it (either in writing or by failing to make written objection thereto), then Owner may subsequently revoke the acceptance of any such Subcontractor, Supplier, or other individual or entity so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity.

F. If Owner requires the replacement of any Subcontractor, Supplier, or other individual or entity retained by Contractor to perform any part of the Work, then Contractor shall be entitled to an adjustment in Contract Price or Contract Times, or both, with respect to the replacement; and Contractor shall initiate a Change Proposal for such adjustment within 30 days of Owner's requirement of replacement.

G. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of the right of Owner to the completion of the Work in accordance with the Contract Documents.

H. On a monthly basis Contractor shall submit to Engineer a complete list of all Subcontractors and Suppliers having a direct contract with Contractor, and of all other Subcontractors and Suppliers known to Contractor at the time of submittal.

I. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions.

J. Contractor shall be solely responsible for scheduling and coordinating the work of Subcontractors, Suppliers, and all other individuals or entities performing or furnishing any of the Work.

K. Contractor shall restrict all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work from communicating with Engineer or Owner, except through Contractor or in case of an emergency, or as otherwise expressly allowed herein.

L. The divisions and sections of the Specifications and the identifications of any Drawings shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

M. All Work performed for Contractor by a Subcontractor or Supplier shall be pursuant to an appropriate contractual agreement that specifically binds the Subcontractor or

Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer.

N. Owner may furnish to any Subcontractor or Supplier, to the extent practicable, information about amounts paid to Contractor on account of Work performed for Contractor by the particular Subcontractor or Supplier.

O. Nothing in the Contract Documents:

1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier, or other individual or entity; nor

2. shall create any obligation on the part of Owner or Engineer to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.

7.07 *Patent Fees and Royalties*

A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.

B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.

C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

7.08 *Permits*

A. Unless otherwise provided in the Contract Documents, Contractor shall obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of the submission of Contractor's Bid (or when Contractor became bound under

a negotiated contract). Owner shall pay all charges of utility owners for connections for providing permanent service to the Work

7.09 *Taxes*

A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

7.10 *Laws and Regulations*

A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.

B. If Contractor performs any Work or takes any other action knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all resulting costs and losses, and shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work or other action. It shall not be Contractor's responsibility to make certain that the Work described in the Contract Documents is in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor's obligations under Paragraph 3.03.

C. Owner or Contractor may give notice to the other party of any changes after the submission of Contractor's Bid (or after the date when Contractor became bound under a negotiated contract) in Laws or Regulations having an effect on the cost or time of performance of the Work, including but not limited to changes in Laws or Regulations having an effect on procuring permits and on sales, use, value-added, consumption, and other similar taxes. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times resulting from such changes, then within 30 days of such notice Contractor may submit a Change Proposal, or Owner may initiate a Claim.

7.11 *Record Documents*

A. Contractor shall maintain in a safe place at the Site one printed record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, written interpretations and clarifications, and approved Shop Drawings. Contractor shall keep such record documents in good order and annotate them to show changes made during construction. These record documents, together with all approved Samples, will be available to Engineer for reference. Upon completion of the Work, Contractor shall deliver these record documents to Engineer.

7.12 *Safety and Protection*

A. Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and

Regulations. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to:

1. all persons on the Site or who may be affected by the Work;
2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, other work in progress, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify Owner; the owners of adjacent property, Underground Facilities, and other utilities; and other contractors and utility owners performing work at or adjacent to the Site, when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property or work in progress.

C. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. The Supplementary Conditions identify any Owner's safety programs that are applicable to the Work.

D. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.

E. All damage, injury, or loss to any property referred to in Paragraph 7.12.A.2 or 7.12.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor at its expense (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).

F. Contractor's duties and responsibilities for safety and protection shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 15.06.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

G. Contractor's duties and responsibilities for safety and protection shall resume whenever Contractor or any Subcontractor or Supplier returns to the Site to fulfill warranty or correction obligations, or to conduct other tasks arising from the Contract Documents.

7.13 *Safety Representative*

A. Contractor shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

7.14 *Hazard Communication Programs*

A. Contractor shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

7.15 *Emergencies*

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent threatened damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby or are required as a result thereof. If Engineer determines that a change in the Contract Documents is required because of the action taken by Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

7.16 *Shop Drawings, Samples, and Other Submittals*

A. *Shop Drawing and Sample Submittal Requirements*:

1. Before submitting a Shop Drawing or Sample, Contractor shall have:

a. reviewed and coordinated the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;

b. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;

c. determined and verified the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and

d. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

2. Each submittal shall bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review of that submittal, and that Contractor approves the submittal.

3. With each submittal, Contractor shall give Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be set forth in a written communication separate from the Shop Drawings or Sample submittal; and, in addition, in the case of Shop Drawings by a specific notation made on each Shop Drawing submitted to Engineer for review and approval of each such variation.

B. *Submittal Procedures for Shop Drawings and Samples*: Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals. Each submittal will be identified as Engineer may require.

1. *Shop Drawings*:

    a. Contractor shall submit the number of copies required in the Specifications.

    b. Data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by Paragraph 7.16.D.

2. *Samples*:

    a. Contractor shall submit the number of Samples required in the Specifications.

    b. Contractor shall clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the submittal for the limited purposes required by Paragraph 7.16.D.

3. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

C. *Other Submittals*: Contractor shall submit other submittals to Engineer in accordance with the accepted Schedule of Submittals, and pursuant to the applicable terms of the Specifications.

D. *Engineer's Review*:

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. Engineer's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.

2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction or to safety precautions or programs incident thereto.

3. Engineer's review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

4. Engineer's review and approval of a Shop Drawing or Sample shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 7.16.A.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer will document any such approved variation from the requirements of the Contract Documents in a Field Order.

5. Engineer's review and approval of a Shop Drawing or Sample shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 7.16.A and B.

6. Engineer's review and approval of a Shop Drawing or Sample, or of a variation from the requirements of the Contract Documents, shall not, under any circumstances,

change the Contract Times or Contract Price, unless such changes are included in a Change Order.

7. Neither Engineer's receipt, review, acceptance or approval of a Shop Drawing, Sample, or other submittal shall result in such item becoming a Contract Document.

8. Contractor shall perform the Work in compliance with the requirements and commitments set forth in approved Shop Drawings and Samples, subject to the provisions of Paragraph 7.16.D.4.

E. *Resubmittal Procedures*:

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous submittals.

2. Contractor shall furnish required submittals with sufficient information and accuracy to obtain required approval of an item with no more than three submittals. Engineer will record Engineer's time for reviewing a fourth or subsequent submittal of a Shop Drawings, sample, or other item requiring approval, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges.

3. If Contractor requests a change of a previously approved submittal item, Contractor shall be responsible for Engineer's charges to Owner for its review time, and Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

7.17 *Contractor's General Warranty and Guarantee*

A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its officers, directors, members, partners, employees, agents, consultants, and subcontractors shall be entitled to rely on Contractor's warranty and guarantee.

B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or

2. normal wear and tear under normal usage.

C. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor's obligation to perform the Work in accordance with the Contract Documents:

1. observations by Engineer;

2. recommendation by Engineer or payment by Owner of any progress or final payment;

3. the issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;

4. use or occupancy of the Work or any part thereof by Owner;

5. any review and approval of a Shop Drawing or Sample submittal;

6. the issuance of a notice of acceptability by Engineer;

7. any inspection, test, or approval by others; or

8. any correction of defective Work by Owner.

D. If the Contract requires the Contractor to accept the assignment of a contract entered into by Owner, then the specific warranties, guarantees, and correction obligations contained in the assigned contract shall govern with respect to Contractor's performance obligations to Owner for the Work described in the assigned contract.

7.18 *Indemnification*

A. To the fullest extent permitted by Laws and Regulations, and in addition to any other obligations of Contractor under the Contract or otherwise, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work or anyone for whose acts any of them may be liable.

B. In any and all claims against Owner or Engineer or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 7.18.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

C. The indemnification obligations of Contractor under Paragraph 7.18.A shall not extend to the liability of Engineer and Engineer's officers, directors, members, partners, employees, agents, consultants and subcontractors arising out of:

1. the preparation or approval of, or the failure to prepare or approve maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or

2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

7.19 *Delegation of Professional Design Services*

A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable Laws and Regulations.

B. If professional design services or certifications by a design professional related to systems, materials, or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.

C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.

D. Pursuant to this paragraph, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 7.16.D.1.

E. Contractor shall not be responsible for the adequacy of the performance or design criteria specified by Owner or Engineer.

ARTICLE 8 – OTHER WORK AT THE SITE

8.01 *Other Work*

A. In addition to and apart from the Work under the Contract Documents, the Owner may perform other work at or adjacent to the Site. Such other work may be performed by Owner's employees, or through contracts between the Owner and third parties. Owner may also arrange to have third-party utility owners perform work on their utilities and facilities at or adjacent to the Site.

B. If Owner performs other work at or adjacent to the Site with Owner's employees, or through contracts for such other work, then Owner shall give Contractor written notice thereof prior to starting any such other work. If Owner has advance information regarding the start of any utility work at or adjacent to the Site, Owner shall provide such information to Contractor.

C. Contractor shall afford each other contractor that performs such other work, each utility owner performing other work, and Owner, if Owner is performing other work with Owner's employees, proper and safe access to the Site, and provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work. Contractor shall do all cutting, fitting, and patching of the

Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected.

D. If the proper execution or results of any part of Contractor's Work depends upon work performed by others under this Article 8, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

8.02 *Coordination*

A. If Owner intends to contract with others for the performance of other work at or adjacent to the Site, to perform other work at or adjacent to the Site with Owner's employees, or to arrange to have utility owners perform work at or adjacent to the Site, the following will be set forth in the Supplementary Conditions or provided to Contractor prior to the start of any such other work:

1. the identity of the individual or entity that will have authority and responsibility for coordination of the activities among the various contractors;

2. an itemization of the specific matters to be covered by such authority and responsibility; and

3. the extent of such authority and responsibilities.

B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

8.03 *Legal Relationships*

A. If, in the course of performing other work at or adjacent to the Site for Owner, the Owner's employees, any other contractor working for Owner, or any utility owner causes damage to the Work or to the property of Contractor or its Subcontractors, or delays, disrupts, interferes with, or increases the scope or cost of the performance of the Work, through actions or inaction, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. Contractor must submit any Change Proposal seeking an equitable adjustment in the Contract Price or the Contract Times under this paragraph within 30 days of the damaging, delaying, disrupting, or interfering event. The entitlement to, and extent of, any such equitable adjustment shall take into account information (if any) regarding such other work that was provided to Contractor in the Contract Documents prior to the submittal of the Bid or the final negotiation of the terms of the Contract. When applicable, any such equitable adjustment in Contract Price shall be conditioned on Contractor assigning to Owner all Contractor's rights against such other contractor or utility owner with respect to the damage, delay, disruption, or interference that is the subject of the adjustment. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.

B. Contractor shall take reasonable and customary measures to avoid damaging, delaying, disrupting, or interfering with the work of Owner, any other contractor, or any utility owner performing other work at or adjacent to the Site. If Contractor fails to take such

measures and as a result damages, delays, disrupts, or interferes with the work of any such other contractor or utility owner, then Owner may impose a set-off against payments due to Contractor, and assign to such other contractor or utility owner the Owner's contractual rights against Contractor with respect to the breach of the obligations set forth in this paragraph.

C. When Owner is performing other work at or adjacent to the Site with Owner's employees, Contractor shall be liable to Owner for damage to such other work, and for the reasonable direct delay, disruption, and interference costs incurred by Owner as a result of Contractor's failure to take reasonable and customary measures with respect to Owner's other work. In response to such damage, delay, disruption, or interference, Owner may impose a set-off against payments due to Contractor.

D. If Contractor damages, delays, disrupts, or interferes with the work of any other contractor, or any utility owner performing other work at or adjacent to the Site, through Contractor's failure to take reasonable and customary measures to avoid such impacts, or if any claim arising out of Contractor's actions, inactions, or negligence in performance of the Work at or adjacent to the Site is made by any such other contractor or utility owner against Contractor, Owner, or Engineer, then Contractor shall (1) promptly attempt to settle the claim as to all parties through negotiations with such other contractor or utility owner, or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law, and (2) indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against any such claims, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such damage, delay, disruption, or interference.

ARTICLE 9 – OWNER'S RESPONSIBILITIES

9.01 *Communications to Contractor*

A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

9.02 *Replacement of Engineer*

A. Owner may at its discretion appoint an engineer to replace Engineer, provided Contractor makes no reasonable objection to the replacement engineer. The replacement engineer's status under the Contract Documents shall be that of the former Engineer.

9.03 *Furnish Data*

A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

9.04 *Pay When Due*

A. Owner shall make payments to Contractor when they are due as provided in the Agreement.

9.05 *Lands and Easements; Reports, Tests, and Drawings*

A. Owner's duties with respect to providing lands and easements are set forth in Paragraph 5.01.

B. Owner's duties with respect to providing engineering surveys to establish reference points are set forth in Paragraph 4.03.

C. Article 5 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of conditions at the Site, and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

9.06 *Insurance*

A. Owner's responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 6.

9.07 *Change Orders*

A. Owner's responsibilities with respect to Change Orders are set forth in Article 11.

9.08 *Inspections, Tests, and Approvals*

A. Owner's responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 14.02.B.

9.09 *Limitations on Owner's Responsibilities*

A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

9.10 *Undisclosed Hazardous Environmental Condition*

A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 5.06.

9.11 *Evidence of Financial Arrangements*

A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract Documents (including obligations under proposed changes in the Work).

9.12 *Safety Programs*

A. While at the Site, Owner's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Owner has been informed.

B. Owner shall furnish copies of any applicable Owner safety programs to Contractor.

ARTICLE 10 – ENGINEER'S STATUS DURING CONSTRUCTION

10.01 *Owner's Representative*

A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract.

10.02 *Visits to Site*

A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe as an experienced and

qualified design professional the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 10.08. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

10.03 *Project Representative*

A. If Owner and Engineer have agreed that Engineer will furnish a Resident Project Representative to represent Engineer at the Site and assist Engineer in observing the progress and quality of the Work, then the authority and responsibilities of any such Resident Project Representative will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in Paragraph 10.08. If Owner designates another representative or agent to represent Owner at the Site who is not Engineer's consultant, agent, or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

10.04 *Rejecting Defective Work*

A. Engineer has the authority to reject Work in accordance with Article 14.

10.05 *Shop Drawings, Change Orders and Payments*

A. Engineer's authority, and limitations thereof, as to Shop Drawings and Samples, are set forth in Paragraph 7.16.

B. Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, are set forth in Paragraph 7.19.

C. Engineer's authority as to Change Orders is set forth in Article 11.

D. Engineer's authority as to Applications for Payment is set forth in Article 15.

10.06 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor as set forth in Paragraph 13.03.

10.07 *Decisions on Requirements of Contract Documents and Acceptability of Work*

A. Engineer will render decisions regarding the requirements of the Contract Documents, and judge the acceptability of the Work, pursuant to the specific procedures set forth herein for initial interpretations, Change Proposals, and acceptance of the Work. In

rendering such decisions and judgments, Engineer will not show partiality to Owner or Contractor, and will not be liable to Owner, Contractor, or others in connection with any proceedings, interpretations, decisions, or judgments conducted or rendered in good faith.

10.08 *Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 10 or under any other provision of the Contract, nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer, shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. Engineer's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 15.06.A will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals, that the results certified indicate compliance with the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 10.08 shall also apply to the Resident Project Representative, if any.

10.09 *Compliance with Safety Program*

A. While at the Site, Engineer's employees and representatives will comply with the specific applicable requirements of Owner's and Contractor's safety programs (if any) of which Engineer has been informed.

ARTICLE 11 – AMENDING THE CONTRACT DOCUMENTS; CHANGES IN THE WORK

11.01 *Amending and Supplementing Contract Documents*

A. The Contract Documents may be amended or supplemented by a Change Order, a Work Change Directive, or a Field Order.

1. *Change Orders*:

a. If an amendment or supplement to the Contract Documents includes a change in the Contract Price or the Contract Times, such amendment or supplement must be set forth in a Change Order. A Change Order also may be used to establish amendments and supplements of the Contract Documents that do not affect the Contract Price or Contract Times.

b. Owner and Contractor may amend those terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, without the recommendation of the Engineer. Such an amendment shall be set forth in a Change Order.

2. *Work Change Directives*: A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the modification ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Work Change Directive's effect, if any, on the Contract Price and Contract Times; or, if negotiations are unsuccessful, by a determination under the terms of the Contract Documents governing adjustments, expressly including Paragraph 11.04 regarding change of Contract Price. Contractor must submit any Change Proposal seeking an adjustment of the Contract Price or the Contract Times, or both, no later than 30 days after the completion of the Work set out in the Work Change Directive. Owner must submit any Claim seeking an adjustment of the Contract Price or the Contract Times, or both, no later than 60 days after issuance of the Work Change Directive.

3. *Field Orders*: Engineer may authorize minor changes in the Work if the changes do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Such changes will be accomplished by a Field Order and will be binding on Owner and also on Contractor, which shall perform the Work involved promptly. If Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, then before proceeding with the Work at issue, Contractor shall submit a Change Proposal as provided herein.

11.02 *Owner-Authorized Changes in the Work*

A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work. Such changes shall be supported by Engineer's recommendation, to the extent the change involves the design (as set forth in the Drawings, Specifications, or otherwise), or other engineering or technical matters. Such changes may be accomplished by a Change Order, if Owner and Contractor have agreed as to the effect, if any, of the changes on Contract Times or Contract Price; or by a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved; or, in the case of a deletion in the Work, promptly cease construction activities with respect to such deleted Work. Added or revised Work shall be performed under the applicable conditions of the Contract Documents. Nothing in this paragraph shall obligate Contractor to undertake work that Contractor reasonably concludes cannot be performed in a manner consistent with Contractor's safety obligations under the Contract Documents or Laws and Regulations.

11.03 *Unauthorized Changes in the Work*

A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents, as amended, modified, or supplemented, except in the case of an emergency as provided in Paragraph 7.15 or in the case of uncovering Work as provided in Paragraph 14.05.

11.04 *Change of Contract Price*

A. The Contract Price may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Price shall comply with the provisions of Paragraph 11.06. Any Claim for an adjustment of Contract Price shall comply with the provisions of Article 12.

B. An adjustment in the Contract Price will be determined as follows:

1. where the Work involved is covered by unit prices contained in the Contract Documents, then by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 13.03); or

2. where the Work involved is not covered by unit prices contained in the Contract Documents, then by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.04.C.2); or

3. where the Work involved is not covered by unit prices contained in the Contract Documents and the parties do not reach mutual agreement to a lump sum, then on the basis of the Cost of the Work (determined as provided in Paragraph 13.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 11.04.C).

C. *Contractor's Fee*: When applicable, the Contractor's fee for overhead and profit shall be determined as follows:

1. a mutually acceptable fixed fee; or

2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:

a. for costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2, the Contractor's fee shall be 15 percent;

b. for costs incurred under Paragraph 13.01.B.3, the Contractor's fee shall be five percent;

c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 11.01.C.2.a and 11.01.C.2.b is that the Contractor's fee shall be based on: (1) a fee of 15 percent of the costs incurred under Paragraphs 13.01.A.1 and 13.01.A.2 by the Subcontractor that actually performs the Work, at whatever tier, and (2) with respect to Contractor itself and to any Subcontractors of a tier higher than that of the Subcontractor that actually performs the Work, a fee of five percent of the amount (fee plus underlying costs incurred) attributable to the next lower tier Subcontractor; provided, however, that for any such subcontracted work the maximum total fee to be paid by Owner shall be no greater than 27 percent of the costs incurred by the Subcontractor that actually performs the work;

d. no fee shall be payable on the basis of costs itemized under Paragraphs 13.01.B.4, 13.01.B.5, and 13.01.C;

e. the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and

f. when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 11.04.C.2.a through 11.04.C.2.e, inclusive.

11.05 *Change of Contract Times*

A. The Contract Times may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Times shall comply with the provisions of Paragraph 11.06. Any Claim for an adjustment in the Contract Times shall comply with the provisions of Article 12.

B. An adjustment of the Contract Times shall be subject to the limitations set forth in Paragraph 4.05, concerning delays in Contractor's progress.

11.06 *Change Proposals*

A. Contractor shall submit a Change Proposal to Engineer to request an adjustment in the Contract Times or Contract Price; appeal an initial decision by Engineer concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; contest a set-off against payment due; or seek other relief under the Contract. The Change Proposal shall specify any proposed change in Contract Times or Contract Price, or both, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents.

1. *Procedures*: Contractor shall submit each Change Proposal to Engineer promptly (but in no event later than 30 days) after the start of the event giving rise thereto, or after such initial decision. The Contractor shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any), to the Engineer and Owner within 15 days after the submittal of the Change Proposal. The supporting data shall be accompanied by a written statement that the supporting data are accurate and complete, and that any requested time or price adjustment is the entire adjustment to which Contractor believes it is entitled as a result of said event. Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal.

2. *Engineer's Action*: Engineer will review each Change Proposal and, within 30 days after receipt of the Contractor's supporting data, either deny the Change Proposal in whole, approve it in whole, or deny it in part and approve it in part. Such actions shall be in writing, with a copy provided to Owner and Contractor. If Engineer does not take action on the Change Proposal within 30 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of Engineer's inaction the Change Proposal is deemed denied, thereby commencing the time for appeal of the denial under Article 12.

3. *Binding Decision*: Engineer's decision will be final and binding upon Owner and Contractor, unless Owner or Contractor appeals the decision by filing a Claim under Article 12.

B. *Resolution of Certain Change Proposals*: If the Change Proposal does not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters, then Engineer will notify the parties that the Engineer is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice shall be deemed a denial, and Contractor may choose to seek resolution under the terms of Article 12.

11.07 *Execution of Change Orders*

A. Owner and Contractor shall execute appropriate Change Orders covering:

1. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive;

2. changes in Contract Price resulting from an Owner set-off, unless Contractor has duly contested such set-off;

3. changes in the Work which are: (a) ordered by Owner pursuant to Paragraph 11.02, (b) required because of Owner's acceptance of defective Work under Paragraph 14.04 or Owner's correction of defective Work under Paragraph 14.07, or (c) agreed to by the parties, subject to the need for Engineer's recommendation if the change in the Work involves the design (as set forth in the Drawings, Specifications, or otherwise), or other engineering or technical matters; and

4. changes in the Contract Price or Contract Times, or other changes, which embody the substance of any final and binding results under Paragraph 11.06, or Article 12.

B. If Owner or Contractor refuses to execute a Change Order that is required to be executed under the terms of this Paragraph 11.07, it shall be deemed to be of full force and effect, as if fully executed.

11.08 *Notification to Surety*

A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times), the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

ARTICLE 12 – CLAIMS

12.01 *Claims*

A. *Claims Process*: The following disputes between Owner and Contractor shall be submitted to the Claims process set forth in this Article:

1. Appeals by Owner or Contractor of Engineer's decisions regarding Change Proposals;

2. Owner demands for adjustments in the Contract Price or Contract Times, or other relief under the Contract Documents; and

3. Disputes that Engineer has been unable to address because they do not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters.

B. *Submittal of Claim*: The party submitting a Claim shall deliver it directly to the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto; in the case of appeals regarding Change Proposals within 30 days of the decision under appeal. The party submitting the Claim shall also furnish a copy to the Engineer, for its information only. The responsibility to substantiate a Claim shall rest with the party making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, or both, Contractor shall certify that the Claim is made in good faith, that the supporting data are accurate and complete, and

that to the best of Contractor's knowledge and belief the amount of time or money requested accurately reflects the full amount to which Contractor is entitled.

C. *Review and Resolution*: The party receiving a Claim shall review it thoroughly, giving full consideration to its merits. The two parties shall seek to resolve the Claim through the exchange of information and direct negotiations. The parties may extend the time for resolving the Claim by mutual agreement. All actions taken on a Claim shall be stated in writing and submitted to the other party, with a copy to Engineer.

D. *Mediation*:

1. At any time after initiation of a Claim, Owner and Contractor may mutually agree to mediation of the underlying dispute. The agreement to mediate shall stay the Claim submittal and response process.

2. If Owner and Contractor agree to mediation, then after 60 days from such agreement, either Owner or Contractor may unilaterally terminate the mediation process, and the Claim submittal and decision process shall resume as of the date of the termination. If the mediation proceeds but is unsuccessful in resolving the dispute, the Claim submittal and decision process shall resume as of the date of the conclusion of the mediation, as determined by the mediator.

3. Owner and Contractor shall each pay one-half of the mediator's fees and costs.

E. *Partial Approval*: If the party receiving a Claim approves the Claim in part and denies it in part, such action shall be final and binding unless within 30 days of such action the other party invokes the procedure set forth in Article 17 for final resolution of disputes.

F. *Denial of Claim*: If efforts to resolve a Claim are not successful, the party receiving the Claim may deny it by giving written notice of denial to the other party. If the receiving party does not take action on the Claim within 90 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of the inaction, the Claim is deemed denied, thereby commencing the time for appeal of the denial. A denial of the Claim shall be final and binding unless within 30 days of the denial the other party invokes the procedure set forth in Article 17 for the final resolution of disputes.

G. *Final and Binding Results*: If the parties reach a mutual agreement regarding a Claim, whether through approval of the Claim, direct negotiations, mediation, or otherwise; or if a Claim is approved in part and denied in part, or denied in full, and such actions become final and binding; then the results of the agreement or action on the Claim shall be incorporated in a Change Order to the extent they affect the Contract, including the Work, the Contract Times, or the Contract Price.

ARTICLE 13 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

13.01 *Cost of the Work*

A. *Purposes for Determination of Cost of the Work*: The term Cost of the Work means the sum of all costs necessary for the proper performance of the Work at issue, as further defined below. The provisions of this Paragraph 13.01 are used for two distinct purposes:

1. To determine Cost of the Work when Cost of the Work is a component of the Contract Price, under cost-plus-fee, time-and-materials, or other cost-based terms; or

2. To determine the value of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price. When the value of any such adjustment is determined on the basis of Cost of the Work, Contractor is entitled only to those additional or incremental costs required because of the change in the Work or because of the event giving rise to the adjustment.

B. *Costs Included*: Except as otherwise may be agreed to in writing by Owner, costs included in the Cost of the Work shall be in amounts no higher than those prevailing in the locality of the Project, shall not include any of the costs itemized in Paragraph 13.01.C, and shall include only the following items:

1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, and vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized by Owner.

2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts shall accrue to Owner. All trade discounts, rebates, and refunds and returns from sale of surplus materials and equipment shall accrue to Owner, and Contractor shall make provisions so that they may be obtained.

3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, who will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 13.01.

4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.

5. Supplemental costs including the following:

   a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.

   b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the

performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.

c. Rentals of all construction equipment and machinery, and the parts thereof, whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.

e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 6.05), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor's fee.

g. The cost of utilities, fuel, and sanitary facilities at the Site.

h. Minor expenses such as communication service at the Site, express and courier services, and similar petty cash items in connection with the Work.

i. The costs of premiums for all bonds and insurance that Contractor is required by the Contract Documents to purchase and maintain.

C. *Costs Excluded*: The term Cost of the Work shall not include any of the following items:

1. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 13.01.B.1 or specifically covered by Paragraph 13.01.B.4. The payroll costs and other compensation excluded here are to be considered administrative costs covered by the Contractor's fee.

2. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.

3. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.

4. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.

5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraph 13.01.B.

D. *Contractor's Fee*: When the Work as a whole is performed on the basis of cost-plus, Contractor's fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price is determined on the basis of Cost of the Work, Contractor's fee shall be determined as set forth in Paragraph 11.04.C.

E. *Documentation*: Whenever the Cost of the Work for any purpose is to be determined pursuant to this Article 13, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer an itemized cost breakdown together with supporting data.

13.02 *Allowances*

A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.

B. *Cash Allowances*: Contractor agrees that:

1. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and

2. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.

C. *Contingency Allowance*: Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

13.03 *Unit Price Work*

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.

B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Payments to Contractor for Unit Price Work will be based on actual quantities.

C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

D. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of the following paragraph.

E. Within 30 days of Engineer's written decision under the preceding paragraph, Contractor may submit a Change Proposal, or Owner may file a Claim, seeking an adjustment in the Contract Price if:

1. the quantity of any item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement;

2. there is no corresponding adjustment with respect to any other item of Work; and

3. Contractor believes that it is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price, and the parties are unable to agree as to the amount of any such increase or decrease.

ARTICLE 14 – TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

14.01 *Access to Work*

A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and authorities having jurisdiction will have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's safety procedures and programs so that they may comply therewith as applicable.

14.02 *Tests, Inspections, and Approvals*

A. Contractor shall give Engineer timely notice of readiness of the Work (or specific parts thereof) for all required inspections and tests, and shall cooperate with inspection and testing personnel to facilitate required inspections and tests.

B. Owner shall retain and pay for the services of an independent inspector, testing laboratory, or other qualified individual or entity to perform all inspections and tests expressly required by the Contract Documents to be furnished and paid for by Owner, except that costs incurred in connection with tests or inspections of covered Work shall be governed by the provisions of Paragraph 14.05.

C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

D. Contractor shall be responsible for arranging, obtaining, and paying for all inspections and tests required:

1. by the Contract Documents, unless the Contract Documents expressly allocate responsibility for a specific inspection or test to Owner;

2. to attain Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work;

3. by manufacturers of equipment furnished under the Contract Documents;

4. for testing, adjusting, and balancing of mechanical, electrical, and other equipment to be incorporated into the Work; and

5. for acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work.

Such inspections and tests shall be performed by independent inspectors, testing laboratories, or other qualified individuals or entities acceptable to Owner and Engineer.

E. If the Contract Documents require the Work (or part thereof) to be approved by Owner, Engineer, or another designated individual or entity, then Contractor shall assume full responsibility for arranging and obtaining such approvals.

F. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation. Such uncovering shall be at Contractor's expense unless Contractor had given Engineer timely notice of Contractor's intention to cover the same and Engineer had not acted with reasonable promptness in response to such notice.

14.03 *Defective Work*

A. *Contractor's Obligation*: It is Contractor's obligation to assure that the Work is not defective.

B. *Engineer's Authority*: Engineer has the authority to determine whether Work is defective, and to reject defective Work.

C. *Notice of Defects*: Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor.

D. *Correction, or Removal and Replacement*: Promptly after receipt of written notice of defective Work, Contractor shall correct all such defective Work, whether or not fabricated, installed, or completed, or, if Engineer has rejected the defective Work, remove it from the Project and replace it with Work that is not defective.

E. *Preservation of Warranties*: When correcting defective Work, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

F. *Costs and Damages*: In addition to its correction, removal, and replacement obligations with respect to defective Work, Contractor shall pay all claims, costs, losses, and damages arising out of or relating to defective Work, including but not limited to the cost of the inspection, testing, correction, removal, replacement, or reconstruction of such defective Work, fines levied against Owner by governmental authorities because the Work is defective, and the costs of repair or replacement of work of others resulting from defective Work. Prior to final payment, if Owner and Contractor are unable to agree as

to the measure of such claims, costs, losses, and damages resulting from defective Work, then Owner may impose a reasonable set-off against payments due under Article 15.

14.04 *Acceptance of Defective Work*

A. If, instead of requiring correction or removal and replacement of defective Work, Owner prefers to accept it, Owner may do so (subject, if such acceptance occurs prior to final payment, to Engineer's confirmation that such acceptance is in general accord with the design intent and applicable engineering principles, and will not endanger public safety). Contractor shall pay all claims, costs, losses, and damages attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness), and for the diminished value of the Work to the extent not otherwise paid by Contractor. If any such acceptance occurs prior to final payment, the necessary revisions in the Contract Documents with respect to the Work shall be incorporated in a Change Order. If the parties are unable to agree as to the decrease in the Contract Price, reflecting the diminished value of Work so accepted, then Owner may impose a reasonable set-off against payments due under Article 15. If the acceptance of defective Work occurs after final payment, Contractor shall pay an appropriate amount to Owner.

14.05 *Uncovering Work*

A. Engineer has the authority to require special inspection or testing of the Work, whether or not the Work is fabricated, installed, or completed.

B. If any Work is covered contrary to the written request of Engineer, then Contractor shall, if requested by Engineer, uncover such Work for Engineer's observation, and then replace the covering, all at Contractor's expense.

C. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, then Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, and provide all necessary labor, material, and equipment.

1. If it is found that the uncovered Work is defective, Contractor shall be responsible for all claims, costs, losses, and damages arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and pending Contractor's full discharge of this responsibility the Owner shall be entitled to impose a reasonable set-off against payments due under Article 15.

2. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, then Contractor may submit a Change Proposal within 30 days of the determination that the Work is not defective.

14.06 *Owner May Stop the Work*

A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, then Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated;

however, this right of Owner to stop the Work shall not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

14.07 *Owner May Correct Defective Work*

A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace rejected Work as required by Engineer, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, then Owner may, after seven days written notice to Contractor, correct or remedy any such deficiency.

B. In exercising the rights and remedies under this Paragraph 14.07, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this paragraph.

C. All claims, costs, losses, and damages incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 14.07 will be charged against Contractor as set-offs against payments due under Article 15. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.

D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 14.07.

ARTICLE 15 – PAYMENTS TO CONTRACTOR; SET-OFFS; COMPLETION; CORRECTION PERIOD

15.01 *Progress Payments*

A. *Basis for Progress Payments*: The Schedule of Values established as provided in Article 2 will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments on account of Unit Price Work will be based on the number of units completed during the pay period, as determined under the provisions of Paragraph 13.03. Progress payments for cost-based Work will be based on Cost of the Work completed by Contractor during the pay period.

B. *Applications for Payments*:

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale,

invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens, and evidence that the materials and equipment are covered by appropriate property insurance, a warehouse bond, or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.

2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment.

3. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

C. *Review of Applications*:

1. Engineer will, within 10 days after receipt of each Application for Payment, including each resubmittal, either indicate in writing a recommendation of payment and present the Application to Owner, or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.

2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

   a. the Work has progressed to the point indicated;

   b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 13.03, and any other qualifications stated in the recommendation); and

   c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:

   a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract; or

   b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:

    a. to supervise, direct, or control the Work, or

    b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or

    c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or

    d. to make any examination to ascertain how or for what purposes Contractor has used the money paid on account of the Contract Price, or

    e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 15.01.C.2.

6. Engineer will recommend reductions in payment (set-offs) necessary in Engineer's opinion to protect Owner from loss because:

    a. the Work is defective, requiring correction or replacement;

    b. the Contract Price has been reduced by Change Orders;

    c. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;

    d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible; or

    e. Engineer has actual knowledge of the occurrence of any of the events that would constitute a default by Contractor and therefore justify termination for cause under the Contract Documents.

D. *Payment Becomes Due*:

1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended (subject to any Owner set-offs) will become due, and when due will be paid by Owner to Contractor.

E. *Reductions in Payment by Owner*:

1. In addition to any reductions in payment (set-offs) recommended by Engineer, Owner is entitled to impose a set-off against payment based on any of the following:

    a. claims have been made against Owner on account of Contractor's conduct in the performance or furnishing of the Work, or Owner has incurred costs, losses, or damages on account of Contractor's conduct in the performance or furnishing of the Work, including but not limited to claims, costs, losses, or damages from workplace injuries, adjacent property damage, non-compliance with Laws and Regulations, and patent infringement;

    b. Contractor has failed to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Site;

c. Contractor has failed to provide and maintain required bonds or insurance;

d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible;

e. Owner has incurred extra charges or engineering costs related to submittal reviews, evaluations of proposed substitutes, tests and inspections, or return visits to manufacturing or assembly facilities;

f. the Work is defective, requiring correction or replacement;

g. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;

h. the Contract Price has been reduced by Change Orders;

i. an event that would constitute a default by Contractor and therefore justify a termination for cause has occurred;

j. liquidated damages have accrued as a result of Contractor's failure to achieve Milestones, Substantial Completion, or final completion of the Work;

k. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;

l. there are other items entitling Owner to a set off against the amount recommended.

2. If Owner imposes any set-off against payment, whether based on its own knowledge or on the written recommendations of Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and the specific amount of the reduction, and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, if Contractor remedies the reasons for such action. The reduction imposed shall be binding on Contractor unless it duly submits a Change Proposal contesting the reduction.

3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 15.01.C.1 and subject to interest as provided in the Agreement.

15.02 *Contractor's Warranty of Title*

A. Contractor warrants and guarantees that title to all Work, materials, and equipment furnished under the Contract will pass to Owner free and clear of (1) all Liens and other title defects, and (2) all patent, licensing, copyright, or royalty obligations, no later than seven days after the time of payment by Owner.

15.03 *Substantial Completion*

A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete and request that Engineer issue a certificate of Substantial Completion. Contractor shall at the same time submit to Owner and Engineer an initial draft of punch list items to be completed or corrected before final payment.

B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.

C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a preliminary certificate of Substantial Completion which shall fix the date of Substantial Completion. Engineer shall attach to the certificate a punch list of items to be completed or corrected before final payment. Owner shall have seven days after receipt of the preliminary certificate during which to make written objection to Engineer as to any provisions of the certificate or attached punch list. If, after considering the objections to the provisions of the preliminary certificate, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the preliminary certificate to Owner, notify Contractor in writing that the Work is not substantially complete, stating the reasons therefor. If Owner does not object to the provisions of the certificate, or if despite consideration of Owner's objections Engineer concludes that the Work is substantially complete, then Engineer will, within said 14 days, execute and deliver to Owner and Contractor a final certificate of Substantial Completion (with a revised punch list of items to be completed or corrected) reflecting such changes from the preliminary certificate as Engineer believes justified after consideration of any objections from Owner.

D. At the time of receipt of the preliminary certificate of Substantial Completion, Owner and Contractor will confer regarding Owner's use or occupancy of the Work following Substantial Completion, review the builder's risk insurance policy with respect to the end of the builder's risk coverage, and confirm the transition to coverage of the Work under a permanent property insurance policy held by Owner. Unless Owner and Contractor agree otherwise in writing, Owner shall bear responsibility for security, operation, protection of the Work, property insurance, maintenance, heat, and utilities upon Owner's use or occupancy of the Work.

E. After Substantial Completion the Contractor shall promptly begin work on the punch list of items to be completed or corrected prior to final payment. In appropriate cases Contractor may submit monthly Applications for Payment for completed punch list items, following the progress payment procedures set forth above.

F. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the punch list.

15.04 *Partial Use or Occupancy*

A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:

1. At any time Owner may request in writing that Contractor permit Owner to use or occupy any such part of the Work that Owner believes to be substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 15.03.A through E for that part of the Work.

2. At any time Contractor may notify Owner and Engineer in writing that Contractor considers any such part of the Work substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 15.03 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 6.05 regarding builder's risk or other property insurance.

15.05 *Final Inspection*

A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work, or agreed portion thereof, is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

15.06 *Final Payment*

A. *Application for Payment*:

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, annotated record documents (as provided in Paragraph 7.11), and other documents, Contractor may make application for final payment.

2. The final Application for Payment shall be accompanied (except as previously delivered) by:

a. all documentation called for in the Contract Documents;

b. consent of the surety, if any, to final payment;

c. satisfactory evidence that all title issues have been resolved such that title to all Work, materials, and equipment has passed to Owner free and clear of any Liens or other title defects, or will so pass upon final payment.

d. a list of all disputes that Contractor believes are unsettled; and

e. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of the Work, and of Liens filed in connection with the Work.

3. In lieu of the releases or waivers of Liens specified in Paragraph 15.06.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (a) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (b) all payrolls, material

and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien, or Owner at its option may issue joint checks payable to Contractor and specified Subcontractors and Suppliers.

B. *Engineer's Review of Application and Acceptance*:

1. If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract have been fulfilled, Engineer will, within ten days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of final payment and present the Application for Payment to Owner for payment. Such recommendation shall account for any set-offs against payment that are necessary in Engineer's opinion to protect Owner from loss for the reasons stated above with respect to progress payments. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable, subject to the provisions of Paragraph 15.07. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. *Completion of Work*: The Work is complete (subject to surviving obligations) when it is ready for final payment as established by the Engineer's written recommendation of final payment.

D. *Payment Becomes Due*: Thirty days after the presentation to Owner of the final Application for Payment and accompanying documentation, the amount recommended by Engineer (less any further sum Owner is entitled to set off against Engineer's recommendation, including but not limited to set-offs for liquidated damages and set-offs allowed under the provisions above with respect to progress payments) will become due and shall be paid by Owner to Contractor.

15.07 *Waiver of Claims*

A. The making of final payment will not constitute a waiver by Owner of claims or rights against Contractor. Owner expressly reserves claims and rights arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 15.05, from Contractor's failure to comply with the Contract Documents or the terms of any special guarantees specified therein, from outstanding Claims by Owner, or from Contractor's continuing obligations under the Contract Documents.

B. The acceptance of final payment by Contractor will constitute a waiver by Contractor of all claims and rights against Owner other than those pending matters that have been duly submitted or appealed under the provisions of Article 17.

15.08 *Correction Period*

A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the Contract Documents, or by any specific provision of the Contract Documents), any Work is found to be defective, or if the repair of any damages to the Site, adjacent areas that

Contractor has arranged to use through construction easements or otherwise, and other adjacent areas used by Contractor as permitted by Laws and Regulations, is found to be defective, then Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:

1. correct the defective repairs to the Site or such other adjacent areas;
2. correct such defective Work;
3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and
4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others, or to other land or areas resulting therefrom.

B. If Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others).

C. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.

D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this paragraph, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

E. Contractor's obligations under this paragraph are in addition to all other obligations and warranties. The provisions of this paragraph shall not be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

ARTICLE 16 – SUSPENSION OF WORK AND TERMINATION

16.01 *Owner May Suspend Work*

A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by written notice to Contractor and Engineer. Such notice will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be entitled to an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension. Any Change Proposal seeking such adjustments shall be submitted no later than 30 days after the date fixed for resumption of Work.

16.02 *Owner May Terminate for Cause*

A. The occurrence of any one or more of the following events will constitute a default by Contractor and justify termination for cause:

1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule);

2. Failure of Contractor to perform or otherwise to comply with a material term of the Contract Documents;

3. Contractor's disregard of Laws or Regulations of any public body having jurisdiction; or

4. Contractor's repeated disregard of the authority of Owner or Engineer.

B. If one or more of the events identified in Paragraph 16.02.A occurs, then after giving Contractor (and any surety) ten days written notice that Owner is considering a declaration that Contractor is in default and termination of the contract, Owner may proceed to:

1. declare Contractor to be in default, and give Contractor (and any surety) notice that the Contract is terminated; and

2. enforce the rights available to Owner under any applicable performance bond.

C. Subject to the terms and operation of any applicable performance bond, if Owner has terminated the Contract for cause, Owner may exclude Contractor from the Site, take possession of the Work, incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and complete the Work as Owner may deem expedient.

D. Owner may not proceed with termination of the Contract under Paragraph 16.02.B if Contractor within seven days of receipt of notice of intent to terminate begins to correct its failure to perform and proceeds diligently to cure such failure.

E. If Owner proceeds as provided in Paragraph 16.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds the cost to complete the Work, including all related claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals) sustained by Owner, such excess will be paid to Contractor. If the cost to complete the Work including such related claims, costs, losses, and damages exceeds such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this paragraph, Owner shall not be required to obtain the lowest price for the Work performed.

F. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue, or any rights or remedies of Owner against Contractor or any surety under any payment bond or performance bond. Any retention or payment of money due Contractor by Owner will not release Contractor from liability.

G. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 6.01.A, the provisions of that bond shall govern over any inconsistent provisions of Paragraphs 16.02.B and 16.02.D.

16.03 *Owner May Terminate For Convenience*

A. Upon seven days written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):

1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;

2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses; and

3. other reasonable expenses directly attributable to termination, including costs incurred to prepare a termination for convenience cost proposal.

B. Contractor shall not be paid on account of loss of anticipated overhead, profits, or revenue, or other economic loss arising out of or resulting from such termination.

16.04 *Contractor May Stop Work or Terminate*

A. If, through no act or fault of Contractor, (1) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (2) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (3) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the contract and recover from Owner payment on the same terms as provided in Paragraph 16.03.

B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this paragraph are not intended to preclude Contractor from submitting a Change Proposal for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this paragraph.

ARTICLE 17 – FINAL RESOLUTION OF DISPUTES

17.01 *Methods and Procedures*

A. *Disputes Subject to Final Resolution*: The following disputed matters are subject to final resolution under the provisions of this Article:

1. A timely appeal of an approval in part and denial in part of a Claim, or of a denial in full; and

2. Disputes between Owner and Contractor concerning the Work or obligations under the Contract Documents, and arising after final payment has been made.

B. *Final Resolution of Disputes*: For any dispute subject to resolution under this Article, Owner or Contractor may:

1. elect in writing to invoke the dispute resolution process provided for in the Supplementary Conditions; or

2. agree with the other party to submit the dispute to another dispute resolution process; or

3. if no dispute resolution process is provided for in the Supplementary Conditions or mutually agreed to, give written notice to the other party of the intent to submit the dispute to a court of competent jurisdiction.

ARTICLE 18 – MISCELLANEOUS

18.01 *Giving Notice*

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if:

1. delivered in person, by a commercial courier service or otherwise, to the individual or to a member of the firm or to an officer of the corporation for which it is intended; or

2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the sender of the notice.

18.02 *Computation of Times*

A. When any period of time is referred to in the Contract by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

18.03 *Cumulative Remedies*

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract. The provisions of this paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

18.04 *Limitation of Damages*

A. With respect to any and all Change Proposals, Claims, disputes subject to final resolution, and other matters at issue, neither Owner nor Engineer, nor any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, shall be liable to Contractor for any claims, costs, losses, or damages sustained by Contractor on or in connection with any other project or anticipated project.

18.05 *No Waiver*

A. A party's non-enforcement of any provision shall not constitute a waiver of that provision, nor shall it affect the enforceability of that provision or of the remainder of this Contract.

18.06 *Survival of Obligations*

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract, as well as all continuing obligations indicated in the Contract, will survive final payment, completion, and acceptance of the Work or termination or completion of the Contract or termination of the services of Contractor.

18.07 *Controlling Law*

A. This Contract is to be governed by the law of the state in which the Project is located.

18.08 *Headings*

A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

END OF SECTION

SECTION 00 73 00
SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement the General Conditions of the Construction Contract, EJCDC® C-700, Copyright © 2013. All provisions that are not so amended or supplemented remain in full force and effect.

The terms used in these Supplementary Conditions have the meanings stated in the General conditions. Additional terms used in these Supplementary Conditions have the meanings stated below, which are applicable to both the singular and plural thereof.

The address system used in these Supplementary Conditions is the same as the address system used in the General Conditions, with the prefix "SC" added thereto

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ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

SC-1.01 Defined Terms

SC-1.01. Add to the list of definitions in Paragraph 1.01.A by inserting the following as numbered items in their proper alphabetical positions:

Geotechnical Data Report (GDR) — The factual report that collects and presents data regarding actual subsurface conditions at or adjacent to the Site, including Technical Data and other geotechnical data, prepared by or for Owner in support of the Geotechnical Baseline Report. The GDR's content may include logs of borings, trenches, and other site investigations, recorded measurements of subsurface water levels, the results of field and laboratory testing, and descriptions of the investigative and testing programs. The GDR does not include an interpretation of the data. If opinions, or interpretive or speculative non-factual comments or statements appear in a document that is labeled a GDR, such opinions, comments, or statements are not operative parts of the GDR and do not have contractual standing. Subject to that exception, the GDR is a Contract Document.

ARTICLE 2 – PRELIMINARY MATTERS

SC-2.01 Delivery of Bonds and Evidence of Insurance

SC-2.01 Delete Paragraphs 2.01 B. and C. in their entirety and insert the following in their place:

B. Evidence of Contractor's Insurance: When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner copies of the policies of insurance (including all endorsements, and identification of applicable self-insured retentions and deductibles) required to be provided by Contractor in Article 6. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

C. Evidence of Owner's Insurance: After receipt from Contractor of the executed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor copies of the policies of insurance to be provided by Owner under Article 6 (if any). Owner may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

SC-2.02 Copies of Documents

SC-2.02.A. Amend the first sentence of Paragraph 2.02.A. to read as follows:

Owner shall furnish to Contractor 2 copies of the Contract Documents (including one fully executed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed sets of the Contract Documents will be furnished upon request at the cost of reproduction.

SC-2.02 Delete Paragraph 2.02.A in its entirety and insert the following new paragraph in its place:

A. Owner shall furnish to Contractor 2 copies of conformed Contract Documents incorporating and integrating all Addenda and any amendments negotiated

prior to the Effective Date of the Contract (including one fully executed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies of the conformed Contract Documents will be furnished upon request at the cost of reproduction.

ARTICLE 5 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

SC-5.01 Availability of Lands

SC-5.01 Add the following new paragraphs immediately after Paragraph 5.01.C:

D. Contractor shall not enter upon nor use any property not under the control of the Owner until a written temporary construction easement agreement has been executed by Contractor and the property owner, and a copy of the easement furnished to the Engineer prior to its use. Neither Owner nor Engineer shall be liable for any claims for damages resulting from Contractor's unauthorized trespass or use of any properties.

SC-5.03 Subsurface and Physical Conditions

SC-5.03 Add the following new paragraphs immediately after Paragraph 5.03.B:

C. The following reports of explorations and tests of subsurface conditions at or adjacent to the Site are known to Owner:

1. Report (Technical Memoranda) titled "Jordanelle Special Service District Water Treatment Plant" by Gerhart Cole, dated August 25, 2020. The Technical Data contained in such report upon whose accuracy Contractor may rely are as indicated in the definition of Technical Data in the General Conditions.

2. Report (Technical Memoranda) titled "Jordanelle Special Service District Water Treatment Plant Aquifer Pump Test" by Gerhart Cole, dated August 26, 2020. The Technical Data contained in such report upon whose accuracy Contractor may rely are as indicated in the definition of Technical Data in the General Conditions.

D. The following drawings of physical conditions relating to existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities) are known to Owner:

1. None

E. Contractor may examine copies of reports and drawings identified in SC 5.03.C and SC 5.03.D that were not included with the Bidding Documents at the office of the Engineer during regular business hours, or may request copies from Engineer.

SC-5.04 Differing Subsurface and Physical Conditions

SC-5.04 Delete subparagraph 5.04.D.2.c in its entirety and replace with the following:

c. Contractor failed to give written notice of differing site conditions within 14 days of discovery and before conditions are disturbed. Failure to

provide written notice constitutes a waiver of all claims in connection therewith, whether direct or consequential in nature.

SC-5.05 Underground Facilities

SC-5.05 Add the following subparagraph 5.05.A.2.e:

e. providing work and assistance (including labor, equipment, and materials) to representatives of underground utility companies associated with relocating or looping underground service lines impacted by the Project.

SC-5.06 Hazardous Environmental Conditions

SC 5.06 Delete Paragraphs 5.06.A and 5.06.B in their entirety and insert the following:

A. No reports or drawings related to Hazardous Environmental Conditions at the Site are known to Owner.

B. Not Used.

ARTICLE 6 – BONDS AND INSURANCE

SC-6.02 Insurance—General Provisions

SC-6.02 Add the following paragraph immediately after Paragraph 6.02.B:

1. Contractor may obtain worker's compensation insurance from an insurance company that has not been rated by A.M. Best, provided that such company (a) is domiciled in the state in which the project is located, (b) is certified or authorized as a worker's compensation insurance provider by the appropriate state agency, and (c) has been accepted to provide worker's compensation insurance for similar projects by the state within the last 12 months.

SC-6.03 Contractor's Liability Insurance

SC 6.03 Add the following new paragraph immediately after Paragraph 6.03.J:

K. The limits of liability for the insurance required by Paragraph 6.03 of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations:

1. Workers' Compensation, and related coverages under Paragraphs 6.03.A.1 and A.2 of the General Conditions:

State:	Statutory

2. Contractor's Commercial General Liability under Paragraphs 6.03.B and 6.03.C of the General Conditions:

General Aggregate	$ 2,000,000
Products - Completed Operations Aggregate	$ 2,000,000
Personal and Advertising Injury	$ 1,000,000

Each Occurrence (Bodily Injury and Property Damage) $ 1,000,000

3. Automobile Liability under Paragraph 6.03.D. of the General Conditions:

Bodily Injury:

Each person $ 1,000,000

Each accident $ 1,000,000

Property Damage:

Each accident $ 1,000,000

[or]

Combined Single Limit of $ 1,000,000

4. Excess or Umbrella Liability:

Per Occurrence $ 4,000,000

General Aggregate $ 4,000,000

5. Contractor's Pollution Liability:

Each Occurrence $ 2,000,000

General Aggregate $ 2,000,000

☐ If box is checked, Contractor is not required to provide Contractor's Pollution Liability insurance under this Contract

6. Additional Insureds: In addition to Owner and Engineer, include as additional insureds the following: Bowen Collins & Associates and Gerhart Cole and their officers, agents and employees.

7. Contractor's Professional Liability:

Each Claim $ 1,000,000

Annual Aggregate $ 2,000,000

SC-6.05 Property Insurance

SC-6.05.A. Add the following language to Paragraph 6.05.A before the sentence stating "*This insurance shall*:"

Contractor shall provide optional terms for builder's risk and/or installation floater insurance. Contractor agrees to have the District approve builder's risk / installation floater insurance program including limits, deductibles, terms, etc. The District shall maintain the right to obtain and implement builder's risk / installation floater coverage at their discretion.

SC-6.05.A.1 Add the following new subparagraph after subparagraph 6.05.A.1:

a. In addition to Owner, Contractor, and all Subcontractors, include as insureds the following:

Bowen Collins & Associates and Gerhart Cole and their officers, agents and employees.

SC-6.05.A. Add the following to the list of items in Paragraph 6.05.A, as numbered items:

15. include by express endorsement coverage of damage to Contractor's equipment.

16. be provided as an optional terms to the Owner. Contractor agrees to have the District approve builder's risk / installation floater insurance program including limits, deductibles, terms, etc. The Owner shall maintain the right to obtain and implement builder's risk / installation floater coverage at their discretion.

ARTICLE 7 – CONTRACTOR'S RESPONSIBILITIES

SC-7.02 Labor; Working Hours

SC-7.02.B. Delete Paragraph 7.02.B in its entirety and insert the following:

B. Except in connection with the safety or protection of persons at the Work, or property at the Project Site or adjacent thereto, all Work at the Project Site shall be performed during regular working hours (7:00 a.m. – 6:00 p.m., Monday through Friday), and the Contractor will not permit overtime work or the performance of work on Saturday, Sunday or any legal holiday observed by the Owner without the Owner's written consent given after prior written notice to the Engineer. Except as otherwise provided in this Paragraph, the Contractor shall receive no additional compensation for overtime work, i.e., work in excess of 8 hours in any one calendar day or 40 hours in any one calendar week, even though such overtime work may be required under emergency conditions and may be ordered by the Engineer in writing. Additional compensation will be paid to the Contractor for overtime work in the event extra work is ordered by the Engineer and the Change Order specifically authorizes the use of overtime work, but only to the extent that the Contractor pays overtime wages on a regular basis being paid (>40 hours per week) for overtime work of a similar nature in the same locality.

SC-7.02.C. Add the following new paragraph immediately after Paragraph 7.02.B:

C. All costs of inspection and testing performed during overtime work approved solely for the convenience of the Contractor shall be borne by the Contractor. The Owner shall have the authority to deduct the costs of the related inspection and testing from any partial payments otherwise due to the Contractor.

ARTICLE 9 – OWNER'S RESPONSIBILITIES

SC-9.13 Owner's Site Representative

SC-9.13 Add the following new paragraph immediately after Paragraph 9.12 of the General Conditions:

SC-9.13 Owner will furnish an "Owner's Site Representative" to represent Owner at the Site and assist Owner in observing the progress and quality of the Work. The

Owner's Site Representative is not Engineer's consultant, agent, or employee. Owner's Site Representative will be identified in pre-construction conference.

ARTICLE 10 – ENGINEER'S STATUS DURING CONSTRUCTION

SC-10.03 Project Representative

SC-10.03 Add the following new paragraphs immediately after Paragraph 10.03.A:

B. The Resident Project Representative (RPR) will be Engineer's representative at the Site, will act as directed by and under the supervision of Engineer, and will confer with Engineer regarding RPR's actions.

1. General: RPR's dealings in matters pertaining to the Work in general shall be with Engineer and Contractor. RPR's dealings with Subcontractors shall only be through or with the full knowledge and approval of Contractor. RPR shall generally communicate with Owner only with the knowledge of and under the direction of Engineer.

2. Schedules: Review the progress schedule, schedule of Shop Drawing and Sample submittals, and Schedule of Values prepared by Contractor and consult with Engineer concerning acceptability.

3. Conferences and Meetings: Attend meetings with Contractor, such as preconstruction conferences, progress meetings, job conferences, and other Project-related meetings, and prepare and circulate copies of minutes thereof.

4. Liaison:

   a. Serve as Engineer's liaison with Contractor. Working principally through Contractor's authorized representative or designee, assist in providing information regarding the provisions and intent of the Contract Documents.

   b. Assist Engineer in serving as Owner's liaison with Contractor when Contractor's operations affect Owner's on-Site operations.

   c. Assist in obtaining from Owner additional details or information, when required for proper execution of the Work.

5. Interpretation of Contract Documents: Report to Engineer when clarifications and interpretations of the Contract Documents are needed and transmit to Contractor clarifications and interpretations as issued by Engineer.

6. Shop Drawings and Samples:

   a. Record date of receipt of Samples and Contractor-approved Shop Drawings.

   b. Receive Samples which are furnished at the Site by Contractor, and notify Engineer of availability of Samples for examination.

   c. Advise Engineer and Contractor of the commencement of any portion of the Work requiring a Shop Drawing or Sample submittal for which RPR believes that the submittal has not been approved by Engineer.

7. Modifications: Consider and evaluate Contractor's suggestions for modifications in Drawings or Specifications and report such suggestions, together with RPR's recommendations, if any, to Engineer. Transmit to Contractor in writing decisions as issued by Engineer.

8. Review of Work and Rejection of Defective Work:

    a. Conduct on-Site observations of Contractor's work in progress to assist Engineer in determining if the Work is in general proceeding in accordance with the Contract Documents.

    b. Report to Engineer whenever RPR believes that any part of Contractor's work in progress is defective, will not produce a completed Project that conforms generally to the Contract Documents, or will imperil the integrity of the design concept of the completed Project as a functioning whole as indicated in the Contract Documents, or has been damaged, or does not meet the requirements of any inspection, test or approval required to be made; and advise Engineer of that part of work in progress that RPR believes should be corrected or rejected or should be uncovered for observation, or requires special testing, inspection or approval.

9. Inspections, Tests, and System Start-ups:

    a. Verify that tests, equipment, and systems start-ups and operating and maintenance training are conducted in the presence of appropriate Owner's personnel, and that Contractor maintains adequate records thereof.

    b. Observe, record, and report to Engineer appropriate details relative to the test procedures and systems start-ups.

10. Records:

    a. Prepare a daily report or keep a diary or log book, recording Contractor's hours on the Site, Subcontractors present at the Site, weather conditions, data relative to questions of Change Orders, Field Orders, Work Change Directives, or changed conditions, Site visitors, deliveries of equipment or materials, daily activities, decisions, observations in general, and specific observations in more detail as in the case of observing test procedures; and send copies to Engineer.

    b. Record names, addresses, fax numbers, e-mail addresses, web site locations, and telephone numbers of all Contractors, Subcontractors, and major Suppliers of materials and equipment.

    c. Maintain records for use in preparing Project documentation.

11. Reports:

    a. Furnish to Engineer periodic reports as required of progress of the Work and of Contractor's compliance with the Progress Schedule and schedule of Shop Drawing and Sample submittals.

    b. Draft and recommend to Engineer proposed Change Orders, Work Change Directives, and Field Orders. Obtain backup material from Contractor.

c. Immediately notify Engineer of the occurrence of any Site accidents, emergencies, acts of God endangering the Work, force majeure or delay events, damage to property by fire or other causes, or the discovery of any Constituent of Concern or Hazardous Environmental Condition.

12. Payment Requests: Review applications for payment with Contractor for compliance with the established procedure for their submission and forward with recommendations to Engineer, noting particularly the relationship of the payment requested to the Schedule of Values, Work completed, and materials and equipment delivered at the Site but not incorporated in the Work.

13. Certificates, Operation and Maintenance Manuals: During the course of the Work, verify that materials and equipment certificates, operation and maintenance manuals and other data required by the Contract Documents to be assembled and furnished by Contractor are applicable to the items actually installed and in accordance with the Contract Documents, and have these documents delivered to Engineer for review and forwarding to Owner prior to payment for that part of the Work.

14. Completion:

    a. Participate in Engineer's visits to the Site to determine Substantial Completion, assist in the determination of Substantial Completion and the preparation of a punch list of items to be completed or corrected.

    b. Participate in Engineer's final visit to the Site to determine completion of the Work, in the company of Owner and Contractor, and prepare a final punch list of items to be completed and deficiencies to be remedied.

    c. Observe whether all items on the final list have been completed or corrected and make recommendations to Engineer concerning acceptance and issuance of the notice of acceptability of the work.

C. The RPR shall not:

1. Authorize any deviation from the Contract Documents or substitution of materials or equipment (including "or-equal" items).

2. Exceed limitations of Engineer's authority as set forth in the Contract Documents.

3. Undertake any of the responsibilities of Contractor, Subcontractors, or Suppliers.

4. Advise on, issue directions relative to, or assume control over any aspect of the means, methods, techniques, sequences or procedures of Contractor's work.

5. Advise on, issue directions regarding, or assume control over security or safety practices, precautions, and programs in connection with the activities or operations of Owner or Contractor.

6. Participate in specialized field or laboratory tests or inspections conducted off-site by others except as specifically authorized by Engineer.

7. Accept Shop Drawing or Sample submittals from anyone other than Contractor.

8. Authorize Owner to occupy the Project in whole or in part.

B. On this Project, by agreement with the Owner, Engineer will not furnish a Resident Project Representative to represent Engineer at the Site or assist Engineer in observing the progress and quality of the Work. 13 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

SC-13.01 Cost of the Work

SC 13.01.B.5.c Delete Paragraph 13.01.B.5.c in its entirety and insert the following in its place:

c. Construction Equipment and Machinery:

1) Rentals of all construction equipment and machinery, and the parts thereof, in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

2) Costs for equipment and machinery owned by Contractor will be paid at a rate shown for such equipment in the Blue Book. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs. Costs will include the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, shall cease to accrue when the use thereof is no longer necessary for the changed Work. Equipment or machinery with a value of less than $1,000 will be considered small tools.

ARTICLE 15 – PAYMENTS TO CONTRACTOR; SET-OFFS; COMPLETION; CORRECTION PERIOD

SC-15.01 Progress Payments:

SC 15.01.D.1 Delete Paragraph 15.01.D.1 in its entirety and insert the following in its place:

1. Forty five (45) days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02.E) become due, and when due will be paid by Owner to Contractor.

SC-15.03 Substantial Completion

SC 15.03.B Add the following new subparagraph to Paragraph 15.03.B:

1. If some or all of the Work has been determined not to be at a point of Substantial Completion and will require re-inspection or re-testing by Engineer, the cost of such re-inspection or re-testing, including the cost of time, travel and living expenses, shall be paid by Contractor to Owner. If Contractor does not pay, or

the parties are unable to agree as to the amount owed, then Owner may impose a reasonable set-off against payments due under Article 15.

ARTICLE 16 – SUSPENSION OF WORK AND TERMINATION

SC-16.04 Contractor May Stop Work or Terminate

SC-16.04.B In Paragraph B, delete the two "30 days" callouts and replace both with "45 days."

ARTICLE 18 – MISCELLANEOUS

SC-18.09 Right to Audit

SC-18.09 Add the following new paragraph immediately after Paragraph 18.08.

SC-18.09 Right to Audit

A. If the Contractor submits a claim to the Owner for additional compensation, the Owner shall have the right, as a condition to considering the claim, and as a basis for evaluation of the claim, and until the claim has been settled, to audit the Contractor's books. This right shall include the right to examine books, records, documents, and other evidence and accounting procedures and practices, sufficient to discover and verify all direct and indirect costs of whatever nature claimed to have been incurred or anticipated to be incurred and for which the claim has been submitted. The right to audit shall include the right to inspect the Contractor's plants, or such parts thereof, as may be or have been engaged in the performance of the Work. The Contractor further agrees that the right to audit encompasses all subcontracts and is binding upon subcontractors. The right to examine and inspect herein provided for shall be exercisable through such representatives as the Owner deems desirable during the Contractor's normal business hours at the office of the Contractor. The Contractor shall make available to the Owner for auditing, all relevant accounting records and documents, and other financial data, and upon request, shall submit true copies of requested records to the Owner.

SC-18.10 Subcontracting Limitation

SC-18.10 Add the following new paragraph immediately after Paragraph 18.09.

SC-19.10 Subcontracting Limitation

A. In addition to the provisions of Article 7.06 of the General Conditions, the Contractor shall perform not less than 50 percent of the Work with its own forces (i.e., without subcontracting) without Owner's prior written approval. This requirement shall be understood to refer to installing, performing, and constructing Work, exclusive of the supply of materials and equipment for the Project.

END OF SECTION

SECTION 00 73 20
CHLORINE RISK MANAGEMENT REQUIREMENT

INTRODUCTION

The Contractor shall be able to accomplish the Work without compromising the safety and health of those at or near the facility. The Contractor shall ensure that its employees and Subcontractors are trained to:

Perform Work Safely

Be aware of provisions of the Owner's EPA Risk Management Program (RMP)/OSHA Process Safety Management (PSM) plan applicable to Owner's chlorination facilities used for the chlorination system. All work done in and adjacent to chlorination systems area or portion of Owner's facility used for the chlorination system must comply with the Owner's safe work practices described in the Owner's RMP Manual and JSAs.

Be aware of potential hazards related to work in or near the Owner's chlorination system or portion of Owner's facility used for the chlorination system. The Contractor is responsible for informing all of its employees, Subcontractors and agents who work in or adjacent to the chlorination facilities used for the chlorination system of the requirements of the Owner's Chlorine Risk Management Program Plan and any information communicated to the Contractor by the Owner regarding chlorine hazards, emergency response plans and other process safety information. All work performed in or adjacent to the chlorination facilities used for the chlorination system must be done in accordance with all requirements of 29 CFR 1910.119.

Applicability

The RMP/PSM program is applicable to all contractors who perform maintenance or repair, turnaround, major renovation, or specialty work on or adjacent to the Owner's chlorination facilities used for the chlorination system. Adjacent in this case is defined as working close enough to the process so that Contractor's work could reasonably be expected to affect process safety and potentially cause, either directly or indirectly, an accidental release of Chlorine. When in doubt, Contractor shall contact the Owner and Engineer.

Contractor Safety Program

Before allowing any employee, Subcontractor or other personnel on site to work near, on or adjacent to Owner's chlorination facilities used for the chlorination system, Contractor shall provide the Owner with a complete copy of Contractor's safety program for review. Contractor's safety program must contain the requirements listed below. The program need not contain all elements if an element is not applicable to the type of work being performed. For example, if Contractor is not using cranes or hoists to perform the required work, Contractor's safety program does not need to address crane and hoist safety. If Contractor has questions, he should refer to OSHA *Safety and Health Regulations for Construction,* Part 1926, and *General Industry Standards,* Part 1910, to help determine if a safety program is applicable to the Work that will be performed.

Contractor Safety Program Requirements

1. General Safety and Health Provisions
2. Occupational Health and Environmental Controls
3. Hazard Communication
4. Process Safety Management of Highly Hazardous Chemicals
5. Personal Protective and Life Saving Equipment
6. Fire Protection and Prevention
7. Signs, Signals and Barricades
8. Materials Handling, Storage, Use and Disposal
9. Tools: Hand and Power
10. Welding and Cutting
11. Electrical
12. Lockout and Tagging
13. Scaffolding
14. Cranes, Derricks, Hoists, Elevators, and Conveyors
15. Motor Vehicles and Mechanized Equipment
16. Excavation, Trenching and Shoring
17. Stairways and Ladders
18. Confined Space Entry
19. Toxic and Hazardous Substances.

The Owner will review Contractor's safety program elements only to determine if required safety program elements are present. Owner has no responsibility to determine if the contents of Contractor's programs meet OSHA safety requirements. Contractor is solely responsible for assuring that its safety programs meet all OSHA requirements. All work performed on or near the Owner's chlorine facility used for the chlorine system shall be in accordance with the Contractor's safety program.

Contractor Safety Training

In addition, before allowing any employee, Subcontractor or other personnel on site to work near, on or adjacent to Owner's chlorination facilities used for the chlorination system, the Contractor must submit records indicating that the Contractor's employees, Subcontractors and agents on site have received safety program training. The training records shall show the names and dates each of Contractor's employees were trained, along with a listing of the safety program elements in which they were trained. In addition, all Contractor's employees and Subcontractors who worked on or near Owner's chlorine facilities used for the chlorine system shall be identified in writing. If Contractor is working at the plant for more than one year, a copy of the Contractor's safety training records shall be provided at least annually to the Owner.

Contractor Safety Log

Before allowing any employee, subcontractor or other personnel on site to work near, on or adjacent to Owner's chlorination facilities used for the chlorination system, the Contractor shall also provide to the Owner a copy of Contractor's OSHA Log and Summary of Injuries and Illnesses Form Number 200 for the five most recent calendar years and the names of at least two references that can attest to Contractor's safety record and performance. During the construction period, the Contractor is required to submit a copy of its OSHA Log and Summary of Injuries and Illnesses Form Number 200

any time an injury or illness on the project is reported as due to working in or adjacent to the chlorination system.

CONTRACTOR BRIEFING

If Contractor is to perform work in or adjacent to the Owner's chlorine facilities used for the chlorine system, a safety "briefing" will be conducted with Contractor's Project Manager, Supervisor and foremen before they begin work. The purpose of this briefing is to make the Contractor aware of the Owner's RMP requirements. Upon arriving at the plant for the first time to perform work, the Contractor's Project Manager, Supervisor, Foreman, will be presented the attached Form 00 73 10-1. The Contractor must read and sign the form. The Owner's representative will then conduct a formal briefing session with the Contractor that summarizes the following:

- The known hazards caused by an accidental release of chlorine.
- Safe work practices including procedures for handling chemicals, lockout/tagout, hot work permit procedure, and equipment and piping disassembly.
- Applicable provisions of the emergency response plan.

All Contractors should receive an Emergency Response Summary Sheet. Contractors working in and around the chlorination process should also receive a copy of process safety information and the emergency response plan developed under the RMP/PSM regulations. In addition, the Contractor should be shown where the RMP/PSM Plan is kept so that it can be used as a reference, if necessary. The briefing form is filed in the RMP/PSM files, which are maintained by the Safety Officer. The Contractor has a responsibility to see that this information is received from Owner.

During the briefing, the following Contractor access control procedures will be reviewed:

- Contactor's employees, Subcontractors, employees of Subcontractors, Suppliers, employees of Suppliers and others are restricted from entering all regulated process areas (chlorination system and portion of chemical building used for chlorination system) unless access is required to perform their work.
- Contactor's employees, Subcontractors, employees of Subcontractors, Suppliers, employees of Suppliers, and others entering a regulated process area (chlorination system and portion of chemical building used for chlorination system) must inform the on-duty Senior Operator, in person or by telephone before entering.

In addition to the Contractor briefing discussed above, Contractors and Subcontractors working in and around the Owner's chlorine facility should receive a walk-through of the process that points out the chemical and equipment locations and the emergency response alarms and evacuation routes. The Contractor has a responsibility to see that he has this information. After receiving this information, the Contractor shall inform his employees and Subcontractors about this information.

FIGURE 00 73 20-1
CONTRACTOR PROCESS SAFETY MANAGEMENT BRIEFING FORM

In accordance with EPA 40 CFR Part 68 Chemical Accident Prevention Requirements: Risk Management Programs Under the Clean Air Act Section 112®(7) and OSHA 29 CFR 1910.119 Process Safety Management (PSM) of Highly Hazardous Materials, I have received a safety briefing from Owner personnel covering chlorine hazards, safe work practices including lockout/tagout, hot work, and emergency response procedures. In no way should this briefing be construed as replacing the required Contractor employee safety training. I further understand that the Owner expects Contractors, including their Subcontractors, Suppliers, agents, and employees of such, to perform construction activities under OSHA required regulations and the Owner procedures, and that they have received all of the required associated training. It is understood that all information presented to me by the Owner staff shall be disseminated to all persons, Subcontractors, Suppliers and agents employed either directly or indirectly by us. I agree to submit documentation as requested by the Owner to verify that our employees, Subcontractors, Suppliers and any other parties working directly or indirectly for us are conveyed the information required and have received any required training. I agree to submit a written statement indicating whether our work presents any unique hazards and a description of those hazards.

Date	**Signature**	**Print Name**	**Company**
_____	_____	_____	_____

[NOTE: The Owner is not responsible for training Contractors, nor does the Owner assume or undertake any duty to Contractor or its employees, Subcontractors or Suppliers by complying with Owner's chlorine RMP.]

DIVISION 01
GENERAL REQUIREMENTS

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SECTION 01 11 00
SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. The Work to be performed under this Contract consists of furnishing all plant, tools, equipment, materials, supplies, and manufactured articles and furnishing all labor, transportation, and services, including fuel, power, water, and essential communications, and performing all Work, or other operations required for the fulfillment of the Contract in strict accordance with the Contract Documents. The Work shall be complete, and all Work, materials, and services not expressly indicated or called for in the Contract Documents, which may be necessary for the complete, safe and proper construction of the Work in good faith shall be provided by Contractor as though originally so indicated, at no increase in cost to Owner.

1.2 WORK COVERED BY CONTRACT DOCUMENTS:

A. The Work of the Contractor comprises construction of a new 24,700 square-foot water treatment plant and pumping facility. The Work generally includes the construction/installation of the following:

1. Construction of a new 4 million gallon per day (mgd) water treatment facility, with anticipated ultimate capacity of 8 mgd
2. The 24,700 square foot building includes the following areas and features:
    a. Main level garage area above the clearwell
    b. Cast in place concrete finished water basement clearwell area below the finished water pump and garage areas
    c. Finished water pump station area with three vertical turbine pumps (with space for two future pumps) and associated surge tank, valves, mechanical piping, flow meter, and electrical.
    d. Snowmaking pump station area with six vertical turbine “canned” pumps and associated surge tank, basket strainer, valves, mechanical piping, flow meter, and electrical
    e. Electrical room and plant power system (with backup diesel generators) and miscellaneous lighting and power systems
    f. Mezzanine finished office space areas, SCADA/controls room, kitchen, and laboratory
    g. Miscellaneous building mechanical systems, HVAC, utilities, security, and piping
    h. CMU building with architectural finishes
3. The installation of Owner purchased/supplied water treatment package system includes the following items:
    a. Installation of owner purchased/supplied water treatment package system (4 mgd total): Four (4) 1 mgd treatment trains, each including valves, flow meters, instrumentation, and walkways. The system generally includes air blowers, flash mixer, flow meters, control valves, PLC controls, and ancillary equipment and

instrumentation. The Owner supplied treatment package system submittal is included with these bid documents.

b. Loading, transportation and off-loading of treatment package equipment from a storage location within 5 miles of the project location.

4. Treatment chemical feed systems in separate containment areas that include:
   a. Caustic Soda feed system with bulk storage and metering pump systems
   b. Primary Coagulant feed system with bulk storage and metering pump systems
   c. Flocculant Aid Polymer storage, blending, and feed system with storage and metering pumps
   d. Installation of new on-site sodium hypochlorite (chlorine) system including on-site generators, power, salt/brine storage system, storage tank, and metering pump systems
   e. Chemical controls systems and instrumentation integrated in the plant controls
5. Sludge drying beds (cast in place concrete 100' x 150') with associated access roads, yard piping, valves, and decant pumping system.
6. Plant under-slab piping for treatment equipment piping connections
7. Plant raw water inlet piping system with basket strainers
8. Plant backwash system with PRVs and pressure relief valves and piping.
9. Civil work including raising and leveling the site, new access roads and asphalt parking area, fencing and site security, and general yard piping, site utilities, and drainage.
10. SCADA hardware and integration by Owner's selected Integrator.

B. The Work is located near Heber, Utah as indicated on the Drawings.

1.3 CONTRACT METHOD

A. The Work hereunder will be constructed under a single lump-sum contract.

1.4 STREAMLINED SPECIFICATIONS

A. These specifications are written in streamlined or declarative style, often using incomplete sentences. This imperative language is directed to Contractor unless specifically noted otherwise.

B. Omissions of such words and phrases as "Contractor shall," "in conformity therewith," "shall be," "as shown on the Drawings," "a," "an," "the," and "all" are intentional in streamlined sections.
   1. Omitted words shall be supplied by inference in the same manner as when a note appears on the Drawings.
   2. Omission of such words shall not relieve Contractor from providing the items and work described herein or indicated on the Drawings.
   3. Words "shall be" are included by inference where a colon (:) is used within sentences or phrases.

1.5 WORK BY OTHERS

A. Owner reserves the right to perform or award other work concurrent with the Work included in this Contract
   1. Work may be conducted at or adjacent to the Site by other contractors during the performance of the Work under this Contract. Conduct operations so as to cause a minimum of interference with the Work of such other contractors and cooperate fully with such contractors to provide continued safe access to their respective portions of the Site, as required to perform Work under their respective contracts.

B. Interference With Work On Utilities:
   1. Cooperate and coordinate fully with all utility forces of Owner or forces of other public or private agencies engaged in the relocation, altering, or otherwise rearranging of any facilities which interfere with the progress of the Work.
   2. Schedule the Work to minimize interference with said relocation, altering, or other rearranging of facilities.

1.6 WORK SEQUENCE AND SCHEDULING CONSTRAINTS

A. Schedule and perform the Work in such a manner as to result in the least possible disruption to the public's use of roadways, driveways, and utilities. Utilities shall include but not be limited to water, sewerage, drainage structures, ditches and canals, gas, electric, cable television, and telephone. Refer to Utility Adjustment and other plan and profile sheets for approximate location of utilities. However, there is no guarantee as to accuracy or completeness. Contractor shall incorporate as-built locations on the reproducible record plans, in red ink, showing proper location on each sheet where these utilities are located.

B. Access to the site is limited to the hours of 6:00 am to 10:00 pm.

1.7 CONTRACTOR USE OF PROJECT SITE

A. Use of the Project Site shall be limited to construction operations, including on-Site storage of materials, on-Site fabrication facilities, and field offices.

B. The Owner has placed limitations for construction operations within certain areas of the project site, see Drawings.

1.8 OWNER USE OF THE PROJECT SITE

A. The Owner shall be allowed safe access to the Project Site during the period of construction.

1.9 CONTRACTOR'S WORKING HOURS

A. Perform work within Owner's regular working hours from 7:00 AM to 5:00 PM on weekdays. If Contractor desires to work overtime or work on a Saturday, Sunday, or any legal holiday, obtain prior approval from Owner and Engineer.

1.10 STORAGE

A. Storage conditions shall be acceptable to Owner for all materials and equipment not incorporated into the Work but included in Applications for Payment. Such storage arrangements and conditions shall be presented in writing for Owner's review and approval and shall afford adequate and satisfactory security and protection. Off-site storage facilities shall be accessible to Engineer. The stored materials shall be insured for full value. Certificates of liability insurance coverage must be submitted to Engineer with the request for payment by Contractor. All arrangements and costs for storage facilities shall be paid by Contractor, unless specifically designated in the Contract Documents to be furnished by Owner.

1.11 NOTICES TO OWNERS OF ADJACENT PROPERTIES AND UTILITIES

A. Notify Owners of adjacent property and utilities when prosecution of the Work may affect them.

B. When it is necessary to temporarily deny access by owners or tenants to their property, or when any utility service connection must be interrupted, Give notices sufficiently in advance to enable the affected person(s) to provide for their needs. Notices shall conform to any applicable local ordinance and, whether delivered orally or in writing, shall include appropriate information concerning the interruption and instructions on how to limit any resulting inconvenience.

C. Utilities and other concerned agencies shall be contacted at least seven days prior to cutting or closing streets or other traffic areas or excavating near underground utilities or pole lines.

D. Review with the various utility companies the construction methods, safety procedures, and Work to be done in the vicinity of utilities. When temporary relocation of utilities is necessary, provide sufficient advance notice to the utility involved.

1.12 LINES AND GRADES

A. Perform all Work to the lines, grades, and elevations shown on the Drawings.

B. Basic horizontal and vertical control points will be established or designated as provided in General Conditions paragraphs. Use these points as datum for the Work. Perform any additional survey, layout, or measurement work needed for proper construction of the Work as a part of the Work at no additional cost to Owner.

C. Employ experienced instrument personnel, competent assistants, and such instruments, tools, stakes, and other materials required to complete the survey, layout, and measurement work. In addition, furnish, without additional charge, competent personnel and such tools, stakes, and other materials as Engineer may require in establishing or designating control points or in checking survey, layout, and measurement of Work performed.

D. Keep Engineer informed, a reasonable time in advance, of the times and places at which Work is to be done, so that horizontal and vertical control points may be established and any checking deemed necessary by Engineer may be done with minimum delay to the Project.

E. Remove and reconstruct Work, which is improperly located.

1.13 PROJECT MEETINGS

A. Preconstruction Conference
   1. Prior to the commencement of Work at the Site, a preconstruction conference will be held at a mutually agreed time and place which shall be attended by Contractor's Project Manager, its Superintendent, its Safety Representative, and its Subcontractors as Contractor deems appropriate. Other attendees will be:
      a. Engineer
      b. Representatives of Owner
      c. Governmental representatives as appropriate
      d. Others as requested by Contractor, Owner, or Engineer
      e. Engineer's Representative
   2. Bring to the conference, any submittals so indicated in Section 01 33 20 – Submittal Procedures.
   3. The purpose of the conference is to designate responsible personnel, discuss contract requirements and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The complete agenda will be furnished by Engineer prior to the meeting date. However, be prepared to discuss all of the items listed below.
      a. Contractor's assignments for safety and first aid, including Designated Competent person(s) and Contractor's safety Representative.
      b. Status of Contractor's insurance and bonds.
      c. Contractor's tentative schedules.
      d. Transmittal, review, and distribution of Contractor's submittals.
      e. Processing applications for payment.
      f. Maintaining record documents.
      g. Critical Work sequencing.
      h. Field decisions and Change Orders.
      i. Use of project site, office and storage areas, security, housekeeping, and Owner's needs.
      j. Major equipment deliveries and priorities.
      k. Permits required for construction.
      l. Utilities required for construction.
      m. Contract Owner and channels of communication.
      n. Coordination with others.
   4. Engineer will preside at the preconstruction conference and will arrange for keeping and distributing the minutes to all persons in attendance.

B. Progress Meetings
   1. Engineer will schedule and hold regular on-Site progress meetings at least weekly and at other times as deemed necessary by Engineer or as required by progress of the Work. Contractor, Engineer and all Subcontractors active on the Site must attend each meeting. Contractor may at its discretion request attendance by representatives of its Suppliers, manufacturers, and other Subcontractors.
   2. Engineer will preside at the meetings and will arrange for keeping and distributing the minutes. The purpose of the meetings will be to review the progress of the Work, discuss safety, maintain coordination of efforts, discuss commercial issues, discuss

changes in scheduling, and resolve other problems, which may develop. During each meeting, all parties are required to present any issues, which may impact its Work, with a view toward resolving these issues expeditiously.

1.14 AVAILABLE SUPPLEMENTAL REPORTS

A. Geotechnical Reports (2 Technical Memoranda): Geotechnical data referenced in these Contract Documents are based upon the documents titled "Gerhart Cole Technical Memorandum for JWTP, August 25, 2020" and "Gerhart Cole Technical Memorandum for JWTP Aquifer Pump Test, August 26, 2020". The document is available from Owner upon request.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 14 33
RIGHTS-OF-WAY

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section covers the designation and conditions related to Work area obtained by Owner.

1.2 RELATED SECTIONS

A. Section 01 11 00 – Summary of Work

B. Section 31 10 00 – Site Preparation

1.3 WORK AREA, EASEMENTS, AND RIGHTS-OF-WAY

A. Work Area:
   1. Work Area Lands: Work areas are shown on the Drawings and are made up of a property the Owner owns or has right of access to. Strictly adhere to all requirements related to use of lands, site preparation, site restoration, and related conditions of these Contract Documents. The lands used to make up work areas consist of Owner property, Owner easements for access from Old Highway 40 roadway established for construction site access and operation access to new facilities.

B. Use of Work Area:
   1. Refer to the General Conditions and Supplementary Conditions of the Contract, along with Section 01 11 00 – Summary of Work, and Section 31 10 00 – Site Preparation for specific limitations to the use of project lands and designated work areas. In addition to the referenced Sections, all other conditions of the Contract Documents shall apply. Use the work area only for activities directly related to the performance of the Work. All items moved, relocated, or otherwise disturbed within the work area shall be returned, repaired, reinstalled, or otherwise replaced to a condition equal to, or better than, its original condition, unless otherwise indicated. All Work associated with returning the site to its original condition shall be subject to the final approval of Engineer.
   2. The provisions regarding the use of the work area shall be applicable to all types of temporary use permits, agreements, and other arrangements intended to provide temporary or permanent use of lands to construct, operate, and maintain the facilities included in the Work. These shall include easements, encroachment permits, license agreements, bilateral agreements, permissions to construct, rights-of-entry, and all other similar agreements.
   3. Permission is granted to use specific work areas as specified. Minimize the use of the available work area as much as possible.

C. Lands that have been or will be made available for use prior to the start of Work are identified in the Contract Drawings.

D. Copies of all plat drawings and legal descriptions for easements and related agreements will be made available by Engineer after written Notice to Proceed, or as they become available.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 14 40
CONSTRUCTION AND SCHEDULE CONSTRAINTS

PART 1 - GENERAL

1.1 SUMMARY

A. Schedule, sequence, and perform the Work in a manner, which minimizes disruption to the public and to the operation and maintenance of existing facilities.

B. Allow for construction and schedule constraints in preparing the construction schedules required under Section 01 32 16 – Construction Progress Schedule. The schedules shall include the activities necessary to satisfy all constraints included and referenced in the Contract Documents.

1.2 PERMITS

A. Abide by the conditions of all permits, easements, and private agreements made and obtain written acceptance of the constructed conditions from each issuer of the permit, easement, or private agreement prior to acceptance of Work by Owner, at no additional expense to Owner.

1.3 COORDINATION WITH OTHER CONSTRUCTION

A. Be responsible for coordinating the Work depicted in the Contract Documents with Owner, Engineer, and all other contractors or suppliers working at, or near the Project Site in accordance with the General Conditions and Supplementary General Conditions.

B. When two or more contracts are being executed at one time on the same, or adjacent land, and in such a manner that work on one contract may interfere with work on another, Owner will determine the sequence and order of the Work. When the territory of one contract is the necessary or convenient means of access for the execution of another contract, such privilege of access or any other reasonable privilege shall be shared unless granted specifically by Owner to one contractor. No such decision as to the method or time of conducting the Work or the use of territory shall be made the basis of any claim for delay or damage, except as provided for in the General Conditions and Supplementary General Conditions.

1.4 SCHEDULE CONSTRAINTS

A. Be responsible to coordinate and plan the construction activities to integrate each schedule constraint into performance of the overall Work.

B. The listing of schedule constraints below does not mean that all constraints or special conditions have been identified. The list is not a substitute for the duty to coordinate and plan for completion, all Work by the Substantial/Contract Completion Dates specified in the Contract Documents.

C. Special Listing: The following constraints affect the construction schedule.

1. Groundwater levels at the site are heavily influenced by the filling of the adjacent the wetlands to the west and to a lesser extent the Timpanogos Canal to the east. Filling of the wetlands starts in March and can extend through October of each year, though only through mid-summer. The timing of the wetland operations varies each year.
2. The Owner selected water treatment package system is anticipated to be manufactured and delivered to Owner in March 2022. The water treatment equipment will be stored within 5 miles of the Project site. When Contractor is ready to install the equipment Contractor will need to coordinate with Engineer and Owner regarding the loading, transportation, and off-loading of the equipment

END OF SECTION

SECTION 01 20 00
MEASUREMENT AND PAYMENT

1.1 DESCRIPTION

A. This Section defines the manner in which the Lump Sum Prices and the Allowances listed in the Bid Schedule will be used to determine measurement and payment for all Work and describes the required procedures for monthly progress payments to the Contractor.

B. Bid amounts will include all plant, equipment, tools materials, labor, service, and all other items required to complete the Work included in the Agreement unless specifically excluded by this section. Work required for which no separate Bid item is identified will be considered as a subsidiary obligation of the Contractor, and the cost therefore shall be included in the most applicable Bid item. Refer to Section 01 32 16 – Construction Progress Schedule (Bar Chart) for resource loading and progress payments. Compensation for partial completion of the Work will be determined by use of the Construction Schedule. Bid amounts for each item will be the basis for development of budget values for activities included in the Construction Schedule and in the Schedule of Values. Adjustments to Allowance Bid Item amounts will be applied to the Contract Price when Work is completed, and actual Allowance item amounts are known.

C. Payment for all items in the Bid Schedule will include full compensation for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of Work being described, as necessary to complete the various items of the Work in accordance with the requirements of the Contract Documents, including all appurtenances thereto, and including but not limited to all costs of permits and cost of compliance with the regulations of public agencies having jurisdiction, including Safety and Health Requirements of the Division of Industrial Safety and the Occupational Safety and Health Administration of the U.S. Department of Labor (OSHA).

D. All costs shall be included in the prices named in the Bid Schedule for the various items of Work. Except as otherwise provided herein, no separate payment will be made for any item that is not specifically set forth in the Bid Schedule.

E. The lump sum item of work, which involves excavation or trenching shall include all costs for such work. No direct payment will be made for excavation or trenching. All excavation and trenching will be unclassified as to materials which may be encountered; in addition, trenches will be unclassified as to depth. No additional payment will be made for rock or caliche excavation, nor for blasting which the Contractor determines is required for rock or caliche excavations.

F. Monthly Applications for Payments (pay requests) are due on the 25th of each month, and while pay requests will be accepted prior to this date, pay request processing will not begin until this date for purposes of meeting the Owner's pay request processing obligations. Failure to submit a pay request by this day may be cause for the rejection of the pay request. If rejected, Contractor may have to resubmit the pay request the next month. Should the submittal date fall on a holiday or weekend day during the month, then consider the next working day as the due date.

G. Note that the information provided in this Section is intended for use as a general description of the breakdown of work to be included in the Bid Schedule. The following descriptions are NOT intended to represent a complete listing of all Work required by the Contract Documents. It is the Bidder's responsibility to make sure that costs for all Work required in the plans and specifications is accounted for in the appropriate Bid Items, whether or not specifically described in this Measurement and Payment section. The Owner is not responsible for Contractor's failure to properly coordinate with Subcontractors and Suppliers regarding the breakdown of Work in these Contract Documents.

1.2 MEASUREMENT AND PAYMENT

A. **Allowance Bid Items (Bid Item No. 2)**

1. None of the amounts of the Allowance Bid items contained in the Bid form may be increased without a Change Order to increase.

2. General Contingency Allowance Item:

a. Include the following amounts in the contract for furnishing and installing products:

1) Owner Initiated Changes Related to WTP Equipment or Other Additional Equipment or Furnishing Needs $100,000

2) Unforeseen Conditions and Owner Requested Changes $200,000

Allowance Total = $300,000

b. Costs NOT Allowed as Part of the Contingency Allowance:

1) Site Dewatering Costs – Contractor is responsible for addressing and estimating these costs during the bid process, utilizing existing geotechnical studies and data. Dewatering efforts are not considered an unforeseen condition.

c. Costs Included in Contingency Allowances:

1) Net cost of product
2) Delivery and unloading at site
3) Applicable taxes
4) Handling at site, including uncrating and storage
5) Protection from elements and from damage
6) Labor, Installation, testing and finishing
7) Other expenses required to finish the installation.

d. Duties of Contractor in providing products by Contingency Allowance:

1) Advise Engineer at least 60 days in advance of purchase date necessary to avoid impacts of Progress Schedule
2) Obtain proposals from suppliers, including:
   a) Quantity
   b) Complete description of product/services provided under allowance
   c) Unit Cost
   d) Total Amount of purchase

e) Taxes and deliveries.

3) On notification of selection, enter into purchase agreement with designated supplier

4) Arrange for delivery and unloading

5) Install products in accordance with Contract Documents

6) Coordinate with Vendors, Equipment Installers, or Integrators

e. Adjustment of Costs

1) When actual cost is more or less than amount allowance, the Contract Price will be adjusted by Change Order.

B. **Integrator Services – Bid Item No. 3**

1. This set price bid item includes the services and materials provided by the Owner's selected Integrator. These generally include the following (See Section 40 61 00):

a. Integrator – The Owner has pre-selected SKM Engineering as the Integrator. The Integrator is responsible to provide all control panel hardware and software not provided in Vendor packages or by AWC (Treatment Package System Supplier). The Integrator shall be responsible to provide all control panels including all PLC hardware, I/O, HMI, networking hardware, and software as indicated in the Drawings and Specifications. The Integrator will also be responsible for all non-HMI SCADA integration, including all hardware and software. The Contractor is responsible for the installation of all control panels provided by the Integrator.

b. The Integrator's detailed scope of work has been provided as part of these bid documents.

C. **Unit Price Imported Fill – Bid Item No. 4**

1. The purpose of this bid item is the import of general fill material.

a. Measurement and Payment for Work under this bid item will be on a cubic yard basis.

b. Payment covers all labor, tools and material costs to import to the site fill material suitable for raising the site to the proposed grades. This unit price applies to Type D material or similar material utilized only for general backfill and site grading.

c. This material must meet the requirements of the earthwork specifications as delivered, see Specification 31 23 00 Section 2.1.C, or be made to meet the specifications prior to placement.

d. Payment excludes: onsite material management; material processing, mixing, crushing, and screening; material placement and grading, material compaction; testing; import material not used for general backfill and grading such as road base, sand, drain rock, CLSM, clay or gravel. These excluded items shall be included in lump sum Bid Item No. 1.

D. **Bid Items A and B – On-Site Sodium Hypochlorite Generator (OSHG) Supplier Bids**

1. The purpose of these two bid items is only for the Owner's information to evaluate equipment pricing and the listed prices are not individually added to or subtracted from the Lump Sum Bid. The Bid Item No. 1 should include the cost of this equipment, delivery and installation costs, and all other costs associated with the OSHG equipment as listed in these specifications.

E. **Lump Sum Bid Items – Bid Item No. 1**

1. All Work Required by the Contract Documents excepting Work included in bid items 2, 3, and 4.

    a. The sum allowed for **Bid Item No. 1** as set forth in the Bid Form includes all Work for and in connection with construction of the Contract in its entirety excepting Work included in bid items 2, 3, and 4..

    b. Payment for Work under this Bid item will be based on the breakdown of costs for each scheduled activity in the Construction Schedule and Schedule of Values and the percentage of completion for each activity in accordance with the Contract Documents.

    c. Preparing the Construction Progress Schedule shall be a separate activity on the Construction Schedule and shall also be a separate activity on the Schedule of Values. Payment for the Construction Progress Schedule is not in addition to, but is incidental to the other lump-sum items included in the Work.

    d. Payment for mobilization, as defined in Section 01 71 00 – Mobilization, as part of the lump sum price named in the Bid Schedule shall equal six percent (6.0%) of the total lump sum price bid for the Work. The payment for mobilization is not in addition to, but is part of the lump sum price for the Work. A separate activity for mobilization shall be included in the Construction Schedule and in the Schedule of Values. This activity shall include all principal items and all submittals specified in Section 01 71 00 – Mobilization, as applicable. The remaining lump sum, except as otherwise required by this Agreement, shall be appropriately distributed among the remaining work activities that make up the total lump sum price. Payment for mobilization will be approved in accordance with the status of completion of each mobilization component as defined in the approved mobilization plan required in Section 01 71 00; except that no payment for mobilization will be approved until Items 1, 2, 8, 9, 10, and 11 of paragraph 3.1.A of Section 01 71 00 are complete. No more than one-half of the payment for mobilization will be paid until all submittals required by paragraph 3.2 of Section 01 71 00 have been approved by the Engineer.

    e. Payment for each approved Operations & Maintenance (O & M) Manual, as defined in Section 01 33 20 – Submittal Procedures, as part of the total lump sum price named in the Bid Schedule shall equal 10% of the value of the piece of equipment or group of like-kind pieces of equipment that it represents. The payment for each O & M Manual is not in addition to but is part of the lump sum price for the Work. A separate activity for each O & M Manual shall be included in the Construction Schedule and in the Schedule of Values.

    f. Bid Item No. 1 shall exclude the Builder's Risk Optional Terms as referenced in Note 16 in Section SC-605.A of the Supplementary Conditions Specification 00 73 00. These optional terms will be included in the contract via change order at the Owner's discretion.

1.3 GENERAL PROGRESS PAYMENT REQUIREMENTS

A. A Payment for Work performed shall be in accordance with installed quantities as assessed in comparison to the Schedule of Values and the Construction Schedule. The Engineer will verify measurements and quantities. Each activity necessary to manage and complete the Work is identified on the Contract schedules. Each activity will be assigned its respective value, a portion of the Contract Price, as shown on the Schedule of Values (Roll-up), and detailed cost loaded activity schedule.

B. Payment for all lump sum costs and services incurred on this Agreement shall be based on the earned value of Work accomplished during the reporting period. Earned value is determined by the completion percentage of each activity as determined by the Schedule of Values and the Construction Schedule applied to the total value of the activity. No construction activity shall be deemed 100 percent complete until the Contractor has completed the physical check out and inspection of the completed Work and has submitted the signed inspection form to the Engineer.

C. Earned value is derived from the current status of the Contractor Construction Schedule as determined by the monthly schedule status submittals. Each schedule status submittal is reviewed and approved by the Engineer prior to the Contractor obtaining approval for the Summary of Earned Values or quantities installed and the Application for Payment.

1.4 APPLICATION FOR PAYMENT

A. Submit application for payment on the Owner's form and be certified by signature of an Authorized Officer of the Contractor.

B. The Application for Payment shall contain all necessary references and attachments that substantiate the invoice for progress payment (e.g., certified payrolls, labor reports, progress schedule data, and Summary of Earned Values). It shall substantiate the invoice for progress payment and shall be preceded or accompanied by the schedule and status data as a condition of payment, in accordance with the Construction Schedule and the Schedule of Values.

1.5 REVIEWS/APPLICATION FOR PAYMENT

A. Review meetings between the Contractor and the Engineer will be held weekly and within 7 Days prior to the payment application date designated by the Engineer. Three Days prior to the last review meeting of the month, submit an updated schedule and a signed application for payment showing a Summary of Earned Values for the reporting and payment period so that the Engineer can compare earned values to available status data. Make any adjustments to the Master Record Documents, updated schedule, and payment applications required by the Engineer. Upon completion of the adjustments, the Engineer will sign the payment request and forward it to the Owner. The Engineer will determine payment amounts if agreement with the Contractor is not reached.

1.6 PAYMENT FOR SUPPLIES AND MATERIALS

A. Payment based on the actual cost of supplies, materials and equipment on hand shall be made by the Owner with or without a paid invoice. "Actual cost" of materials shall be the invoice

amount, whether paid or not, and shall not include any costs associated with installation, testing, etc. The Contractor shall be entitled to payment of the actual cost of supplies, materials and equipment only if it (1) presents an invoice to the Owner with the application for payment and (2) states in the application for payment that the materials have been delivered and stored in the time and manner specified in the contract between the Contractor and his Supplier or Subcontractor. If Contractor fails to comply with those conditions, the Owner may withhold payment in accordance with the provisions. The Owner expressly reserves the right to withhold retention until Contractor presents to the Owner a paid invoice, or some other proof of payment satisfactory to the Owner, for the Owner's use in verifying the accuracy of the actual cost of the supplies, materials or equipment. If the amount paid does not match the actual cost, the Owner will adjust the amount of retention accordingly. Payment for supplies, materials or equipment on hand does not alter the responsibility of the Contractor for all supplies, materials and equipment until Final Acceptance of the Work.

END OF SECTION

SECTION 01 25 10
PRODUCTS, MATERIALS, EQUIPMENT, AND SUBSTITUTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for delivery and storage of products and materials specified for use in the Project. It also includes requirements for handling requests for equals and substitutions made after award of the Contract.

1.2 RELATED SECTIONS

A. Section 01 32 00 – Electronic Project Management System

1.3 DEFINITIONS

A. Definitions in this Article are not intended to negate the meaning of other terms used in the Contract Documents, including "specialties," "systems," "structure," "finishes," "accessories," "furnishings," “special construction," and similar terms, which are self-explanatory and have recognized meanings in the construction industry.

B. The word "Products," as used herein, is defined to include purchased items for incorporation into the Work, regardless of whether specifically purchased for the Project or taken from stock of previously purchased products.

C. The word "Materials," is defined as products which must be substantially cut, shaped, worked, mixed, finished, refined, or otherwise fabricated, processed, installed, or applied to form units of work.

D. The word "Equipment" is defined as products with operational parts, regardless of whether motorized or manually operated, and particularly including products with service connections (wiring, piping, and other like items).

E. Neither "Products" nor "Materials" nor "Equipment" includes machinery and equipment used for preparation, fabrication, conveying and erection of the Work.

1.4 QUALITY ASSURANCE

A. Source Limitations: To the greatest extent possible for each unit of work, provide products, materials, and equipment of a singular generic kind from a single source.

B. Compatibility of Options: Where more than one choice is available as options for selection of a product, material, or equipment, select an option, which is compatible with other products, materials, or equipment. Compatibility is a basic general requirement of product, material and equipment selections.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance
   1. Deliver and store products, materials, and equipment in accordance with manufacturer's written recommendations and by methods and means which will prevent damage, deterioration, and loss including theft.
   2. Manage delivery schedules to minimize long-term storage of products at Site and overcrowding of construction spaces. Ensure coordination to minimize holding or storage times for flammable, hazardous, easily damaged, or sensitive materials to deterioration, theft, and other sources of loss.

B. Transportation and Handling
   1. Transport products by methods to avoid damage. Deliver in undamaged condition in manufacturer's unopened containers and packaging.
   2. Furnish equipment and personnel to handle products, materials, and equipment, including those provided by Owner, by methods to prevent soiling and damage.
   3. Provide additional protection during handling to prevent marring and otherwise damaging products, packaging, and surrounding surfaces.

C. Storage and Protection
   1. Products shall be stored in accordance with manufacturer's written instructions and with seals and labels intact and legible. Sensitive products shall be stored in weather-tight climate-controlled enclosures and temperature and humidity ranges shall be maintained within tolerances required by manufacturer's recommendations.
   2. For exterior storage of fabricated products, products shall be placed on sloped supports above ground. Products subject to deterioration shall be covered with impervious sheet covering and ventilation shall be provided to avoid condensation.
   3. Loose granular materials shall be stored on solid flat surfaces in a well-drained area and shall be prevented from mixing with foreign matter.
   4. Storage shall be arranged to provide access for inspection. Periodically inspect to assure products are undamaged and are maintained under required conditions.
   5. Storage shall be arranged in a manner to provide access for maintenance of stored items and for inspection.

D. Maintenance of Storage
   1. Periodically inspect stored products on a scheduled basis. Maintain a log of inspections and make the log available on request.
   2. Comply with manufacturer's product storage requirements and recommendations.
   3. Maintain manufacturer-required environmental conditions continually.
   4. Ensure that surfaces of products exposed to the elements are not adversely affected and that weathering of finishes does not occur.
   5. For mechanical and electrical equipment, provide a copy of the manufacturer's service instructions with each item and the exterior of the package shall contain notice that instructions are included.
   6. Service products on a regularly scheduled basis. Maintain a log of services and submit as a record document prior to acceptance by Owner in accordance with the Contract Documents.

1.6 PROPOSED SUBSTITUTIONS AND "OR EQUAL" ITEMS

A. Substitution and “or equal” determination shall be submitted and evaluated per the General Conditions included in the Contract Documents.

B. When proposing a substitution, transmit all documents to Engineer in electronic format (single PDF), via web-based construction management software as specified in Section 01 32 00 – Electronic Project Management System.

C. Unless otherwise provided by law or authorized in writing by Engineer, submit the "Substitution Request Form(s)" within 35 days after award of the Contract.

D. Whenever products, materials, or equipment are indicated in the Contract Documents by using the name of a proprietary item or the name of a particular supplier, the naming of the manufacturer is intended to establish the type, function, and quality required. The Contract Price is understood to be based upon furnishing the item specified.

E. If a named item is not available or a supplier is no longer doing business, the following shall apply:
   1. When a named supplier is no longer doing business under the name indicated, furnish the specified product from the legal successors to the named supplier.
   2. When a named product is no longer available from the named supplier due to acquisition or sale of the given product line, but the product is available from another supplier, provide the named product. In such cases, submit a substitution request form and include certification from the supplier that the product being supplied is materially and functionally identical to the product named in the Contract Documents.
   3. When the named product is no longer available from the named supplier or any other supplier, notify Owner in writing and Owner will direct Engineer to identify suitable substitute products. Provide one of the suitable substitute products.

F. The procedure for review by the Engineer will include the following:
   1. Wherever a proposed substitution has not been submitted within said 35-day period, or wherever the submission of a proposed substitution material or equipment has been judged to be unacceptable by Engineer, provide the product, material, or equipment indicated in the Contract Documents.
   2. Certify that the proposed substitution will adequately perform the functions and achieve the results called for by the general design and be similar and of equal substance to that indicated and be suited to the same use as that indicated.
   3. Engineer will evaluate each proposed substitution within a reasonable period.
   4. As applicable, do not make shop drawing submittals for a substitution without Engineer's prior written acceptance of the request for substitution. Do not order, install, or utilize any substitution item prior to written acceptance of the request for substitution.
   5. Engineer will record the time required by Engineer in evaluating substitutions and in making changes by Contractor in the Contract Documents occasioned thereby.

G. Application for substitution must contain the following statements and information, which will be considered by Engineer in evaluating the proposed substitution:
   1. Submit "Substitution Request Form," at end of this Section, fully executed.
   2. The evaluation and acceptance of the proposed substitution shall not prejudice the achievement of substantial completion on time.
   3. Whether or not acceptance of the substitution for use in the Work will require a change in any of the Contract Documents to adapt the design to the proposed substitution.
   4. Whether or not incorporation or use of the substitution in connection with the Work is subject to payment of any license fee or royalty.
   5. All variations of the proposed substitution from the items originally specified shall be identified.
   6. Available maintenance, repair, and replacement service shall be indicated. The manufacturer shall have a local service agency (within 50 miles of the site) which maintains properly trained personnel and adequate spare parts and is able to respond and complete repairs within 24 hours.
   7. Itemized estimate of all costs that will result directly or indirectly from acceptance of such substitution, including cost of redesign and claims of other contractors affected by the resulting change.

H. Without any increase in cost to Owner, be responsible for, and pay all costs in connection with proposed substitutions and costs of inspections and testing of equipment or materials submitted for review prior to purchase thereof for incorporation in the Work, whether or not Engineer accepts the proposed product, equipment, or material. Reimburse Owner for the charges of Engineer and other authorized representatives for evaluating each proposed substitution.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

BOWEN COLLINS & ASSOCIATES

SUBSTITUTION REQUEST FORM

To: _____ Project: _____

_____ Date: _____

_____ Owner: _____

Specified Item:

Section	Page	Paragraph	Description

The undersigned requests consideration of the following:

Proposed Substitution: _____

Attached data includes product description, specifications, drawings, photographs, performance and test data adequate for evaluation of the request. Applicable portions of the data are clearly identified.

The undersigned states that the following paragraphs, unless modified on attachments, are correct:

1. The proposed substitution does not affect dimensions shown on Drawings and will not require a change in any of the Contract Documents.
2. The undersigned will pay for changes to the design, including engineering design, detailing, and construction costs caused by the request substitution which is estimated to be $.
3. The proposed substitution will have no adverse effect on other contractors, the construction schedule (specifically the date of substantial completion), or specified warranty requirements.
4. Maintenance and service parts will be locally available for the proposed substitution.
5. The incorporation or use of the substitute in connection with the work is not subject to payment of any license fee or royalty.

The undersigned further states that the function, appearance, and quality of the proposed substitution are equivalent or superior to the specified item.

Submitted by **Contractor:**		Reviewed by **Engineer:**	
Firm:		☐ Accepted as Submitted	☐ Accepted as Noted
By:		☐ Not Accepted	☐ Received too Late
Signature:		By:	
Telephone:		Title:	
Attachments:		Date:	
Comments:		Comments:	

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SECTION 01 26 13
REQUESTS FOR INTERPRETATION (RFI)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes procedures for submitting Requests for Interpretation (RFI) and limitations on use of RFI to obtain interpretation and clarification.

1.2 RELATED SECTIONS

A. Section 01 25 10 – Products, Materials, Equipment and Substitutions.

B. Section 01 32 00 – Electronic Project Management System.

C. Section 01 33 20 – Submittal Procedures.

1.3 DEFINITIONS

A. Request for Interpretation: A document submitted to Engineer by Contractor, requesting clarification of a portion of the Contract Documents, hereinafter referred to as an RFI.

1.4 CONTRACTOR'S REQUESTS FOR INTERPRETATION (RFI)

A. Contractor's Requests for Interpretation (RFI): Should Contractor be unable to determine from the Contract Documents, the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of Work is described differently at more than one place in the Contract Documents; request that Engineer make an interpretation of the requirements of the Contract Documents to resolve such matters. Comply with procedures specified herein to make Requests for Interpretation (RFI).

B. Submission of RFI: Prepare RFI and submit electronically utilizing the Electronic Project Management System. Refer to Section 01 32 00 – Project Management System.
   1. Fill in transmittal form completely, and if supplemental drawings or other information is prepared by hand, it shall be fully legible and attached with the transmittal form.
   2. The Project Management System will automatically assign each RFI a discrete, consecutive number. Include this number in the title of the RFI. For instance, Revision #1 to RFI 029 should be noted in the title as "*original title name*, Rev 1.
   3. Each page of the RFI and each attachment to the RFI shall bear Owner's project name, project number, date, RFI number and a descriptive title. Merge all into a single PDF document for attachment in the system.
   4. Clearly and concisely set forth the issue for which clarification or interpretation is sought and why a response is needed. In the RFI, indicate presumed interpretation or understanding of the requirement along with reasons for such understanding.

Include proposed solutions that may be set forth to complete the Work with associated cost and schedule impact, if any.

5. Engineer will review all RFI to determine whether they are RFI within the meaning of the term. If Engineer determines that the transmittal is not an RFI, it will be returned, unreviewed as to content, for resubmittal in the proper manner.
6. Frivolous RFI or simply passing on the RFI without first vetting the RFI will be subject to reimbursement from Contractor to Owner for fees charged by Engineer and other design professionals engaged by Owner.

C. Subcontractor-Initiated and Supplier-Initiated RFI: RFI from subcontractors and material suppliers shall be submitted through, be reviewed by, and be attached to an RFI prepared, signed, and submitted by Contractor. RFI submitted directly by subcontractors or material suppliers will be returned unanswered to Contractor.

1. Review all subcontractor- and supplier-initiated RFI and take actions to resolve issues of coordination, sequencing, and layout of the Work. Coordination of the work, sequence, and layout are not the responsibility of Owner or Engineer.
2. RFI submitted to request clarification of issues related to means, methods, techniques, and sequences of construction or for establishing trade jurisdictions and scopes of subcontracts will be returned without interpretation. Such issues are solely Contractor's responsibility.

D. Requested Interpretation: Carefully study the Contract Documents to ensure that information sufficient for interpretation of requirements of the Contract Documents is not included therein. RFI that request interpretation of requirements clearly indicated in the Contract Documents will be returned without interpretation.

1. In all cases in which RFI are issued to request clarification of issues related to means, methods, techniques and sequences of construction; for example, pipe and duct routing, clearances, specific locations of Work shown diagrammatically, apparent interferences and similar items, furnish all information required for Engineer or Owner to analyze and/or understand the circumstances causing the RFI and prepare a clarification or direction as to how to proceed.
2. If information included with this type of RFI is insufficient, the RFI will be returned unanswered.

E. Unacceptable Uses for RFI: RFI shall not be used to request the following:

1. Approval of submittals (use procedure specified in Section 01 33 20 - Submittal Procedures).
2. Approval of substitutions (refer to Section 01 25 10 – Products, Materials, Equipment and Substitutions).
3. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Contract General Conditions).
4. Different methods of performing Work than those indicated in the Contract Drawings and Specifications (comply with provisions of the Contract General Conditions).

F. Disputed Requirements: If Engineer’s response to an RFI is believed to cause a change to the requirements of the Contract Documents, immediately give written notice to Engineer stating why this is believed to be true. Failure to give such written notice immediately shall waive any right to seek additional time or compensation under the Contract.

PART 2 - PRODUCTS

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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BOWEN COLLINS & ASSOCIATES

REQUEST FOR INTERPRETATION

RFI No: _____

Project No: _____

Project: _____ **Date:** _____

Owner: _____

Engineer: _____ Construction Mgr: _____

Contractor: _____ Contractor PM: _____

Subject: _____

Drawing No: _____ Specification Sect: _____

Contractor's Request for Interpretation (RFI)
Contractor's Signature: Date:

Engineer's Response
Engineer's Signature: Date:

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SECTION 01 29 73
SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 GENERAL

A. This Section defines the process whereby the Schedule of Values shall be developed and incorporated into the Construction Progress Schedule as specified in Section 01 32 16 – Construction Progress Schedule. Monthly progress payment amounts shall be determined from the weekly progress updates of the scheduled activities. The schedule of values shall, as a minimum, list the value of every activity on the schedule, and shall include such additional breakdowns as required herein. The values in the Schedule of Values do not establish a commitment by either Contractor or Owner when negotiating changes to the Contract Documents.

1.2 DETAILED SCHEDULE OF VALUES

A. Prepare and submit a detailed Schedule of Values to Engineer as part of the Construction Progress Schedule submittal. Because the ultimate requirement is to develop a detailed Schedule of Values sufficient to determine appropriate monthly progress payment amounts, sufficient detailed breakdown shall be provided to meet this requirement. The Schedule of Values shall have a one-to-one relationship to the work activities of the Construction Progress Schedule even though additional detailed breakdowns for the Schedule of Values may be required. Engineer will be the sole judge of acceptable breakdowns, details, and descriptions of the values established. If, in the opinion of Engineer, a greater number of Schedule of Values items than proposed is necessary, add the additional items so identified.

B. The minimum details of a breakdown of the major Work components are indicated below. Provide greater detail when directed by Engineer. Also of note is that the Owner desires a best effort by the Contractor to break down the snowmaking pump facility costs as it is divided out into mechanical, electrical, controls, programming, and startup.

1. Mobilization: Six percent of Contract Price.
2. Construction Progress Schedule shall be broken down by initial submittal and monthly updates.
3. Break down Civil site Work into access roads, clearing and grubbing, dewatering activities, excavation cut and fill, site drainage, site final grading, site concrete, paving, fencing, and any other items determined to be necessary for the establishment of pay and activity items.
4. Break down structures into subgrade preparation, appurtenant pre-foundation Work, concrete foundation/footing construction, slabs on grade, columns, suspended slabs, crane system, decking, CMU walls, roof trusses, etc. (provide sufficient breakdown to accommodate necessary schedule detail).
    a. Break down generally by main building, sludge drying beds, and exterior vaults.
    b. Break down snowmaking vault separately.

5. Break down by loading, transportation, and offloading of water treatment equipment from Owner storage location.

6. Break down mechanical Work (equipment, tanks, valves, pumps, above grade piping, and subgrade piping) within each area of the facility to identify individual piping systems, equipment installation by equipment name and number, and equipment testing and checkout.

    a. Break down by water treatment plant (WTP) area and facilities, finished water pumping, individual chemical feed areas, and building office area.

    b. Break out separately all snowmaking pump specific mechanical.

7. Break down electrical and instrumentation Work within each structure to identify individual systems, equipment installation by equipment name and number, and equipment testing and checkout.

    a. For electrical, break down by diesel generators, electrical systems (pumping vs WTP power), yard power conduit, power connections, electrical room equipment, building lighting, building security, etc.

    b. Break out separately all snowmaking pump specific electrical, including its backup generator, wiring/conduit, power, controls.

    c. Break down programming and SCADA integration work by Owner's selected Integrator scope of supply and scope of work. This item should have snowmaking SCADA controls and monitoring broken out separately.

8. Break down protective coating Work by system. Where specific coating Work may be critical to performing the Work to meet milestone and schedule dates, such Work shall be included as individual pay and activity items.

9. Break down yard piping Work into individual pipelines (snowmaking/raw water vs culinary water vs waste pipelines) and by items including pipe, specials, and other pipe materials, excavation, pipe installation, joint welding (including testing), joint protection, trench backfill, surface restoration, and hydrostatic testing; and any other items determined necessary for the establishment and pay and schedule activities.

10. Provide breakdown for disinfection, testing, and commissioning of pipelines and clearwell.

11. Provide breakdown for WTP and finished water pump startup – keep snowmaking pump facility startup separate.

12. Operations and Maintenance (O & M) Manuals shall be broken down into one O & M Manual per piece of equipment or one O & M Manual per group of like-kind pieces of equipment for establishment of pay and schedule activity items.

13. Break down all other Work not specifically included in the above items as necessary for establishment of pay and schedule activity items.

C. After submittal of the Schedule of Values, as part of the Construction Progress Schedule submittal, meet with Engineer and jointly review the schedules. Review the value allocations and extent of detail to determine any necessary adjustments to the values and to determine if sufficient detail has been proposed. Make adjustments deemed necessary to the value

allocation or level of detail and submit a revised detailed Schedule of Values within 5 work days from receipt of comments from Engineer.

1.3 CHANGES TO SCHEDULE OF VALUES

A. Assign values, approved by Engineer, for changes to the Construction Schedule which add activities not included in the original Construction Schedule but are included in the original Work (schedule omissions). Reduce other activity values to provide equal value adjustment increases for added activities as approved by Engineer.

B. In the event that Contractor and Engineer agree to make adjustments to the original Schedule of Values because of inequities discovered in the original accepted detailed Schedule of Values, increases and equal decreases to values for activities may be made. Engineer may direct changes to the schedule when inequities are discovered and agreement on the reallocation cannot be achieved.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

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SECTION 01 31 30
SAFETY

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor's safety program shall conform to the requirements specified in the General Conditions and Supplementary Conditions.

1.2 DEFINITIONS

A. For the purposes of this Section, an "active construction area" is any area where construction activities are occurring, or construction activities could be considered a potential hazard to people.

B. A "Designated Safety Officer" or "Safety Representative" for the purposes of this Contract, means anyone who is capable of identifying the existing and predictable hazards in the areas surrounding a construction project or those working conditions at a construction project that are unsanitary or dangerous to employees. A "Designated Safety Officer" has the authority to make prompt corrective measures to eliminate those hazards.

1.3 SUBMITTALS

A. Demonstrate compliance action with the stipulations of Occupational Safety and Health Administration (OSHA), Mine Safety and Health Administration (MSHA), and other applicable local, state, and federal safety requirements by submitting to Engineer a copy of all safety plans, programs, and permits. Such plans and programs shall include, but are not limited to:
   1. Hazard Analysis Prior to Major Activities (job safety analysis, JSA).
   2. Emergency Plan.
   3. Rigging and Hoisting Plans.
   4. Excavation and Trenching Plans.
   5. Respiratory Protection Program.
   6. Fire Protection Plan.
   7. Confined Space Entry Program.
   8. Explosives Handling and Storage.
   9. Confined Space Entry Program.
   10. Electrical Safety (drop cords, temporary power, GFCI's, etc.)
   11. Lock Out/Tag Out.
   12. Fall Protection.
   13. Heavy Equipment Operations.
   14. Burning and Welding Operations.
   15. Training Plan.
   16. Tunneling/Underground/Jacking/Boring Operations.
   17. Project Site Rules and Regulations (hazard protection plan).
   18. Material Handling (storage-disposal).
   19. Fuel Storage and Refueling.
   20. Hazard Communication/Right to Know.
   21. Subcontractor Requirements.

22. Ventilation.
23. Personal Protective Equipment (hearing, eye, face).
24. Power Transmission/Distribution (temporary and/or permanent).
25. Traffic Control.
26. Environmental Controls.
27. Safety Meetings.
28. Spill Control Plan.
29. First Aid Facilities.

B. Engineer's receipt of safety plans or programs will not relieve Contractor in any way from the full and complete responsibility for safety and training of its personnel, and the onsite personnel of Owner, Engineer, and other visitors to areas of active construction areas. On a daily basis, inform Engineer of changes to the boundaries of the active construction areas.

C. Be responsible for safety training all personnel who will have access to the active construction areas to meet state, federal, local and Contractor requirements. Maintain reasonable, regularly scheduled training sessions in mutually accessible facilities through entire Contract. Training costs for all personnel and visitors, except those costs associated with training personnel of Contractor, subcontractors, suppliers, and visitors will be considered incidental to other lump-sum portions of the Work and no additional compensation for such training will be provided.

D. Safety Program Requirements:
   1. Safety Representative Requirements:
      a. Assign a Safety Representative as defined in the General Conditions of the Contract.
      b. The Safety Representative's duties and responsibilities will be hazard recognition, accidents prevention, new employee orientation (including subcontractors), and the maintaining and supervising of safety precautions and program. This person shall have no other duties. The Safety Representative or a qualified and approved deputy shall be onsite while Work is ongoing, as necessary according to the Contractor's Safety Plan.
      c. Qualifications of the Safety Representative and assigned deputies shall be submitted to Engineer for review. Acceptance of their qualifications by Engineer is required prior to the start of any activity on the Project. The Safety Representative will, as a minimum, meet the requirements of regulations for the Occupational Safety & Health Enforcement Program.
   2. Hazardous Substances:
      a. Provide Engineer with a list of all hazardous substances anticipated to be brought on-site.
      b. Maintain on site Material Safety Data Sheets (MSDS) prior to arrival of any hazardous substances on the Project.
      c. Use storage area(s) as outlined in the spill control plan.
   3. Job Safety Analysis (JSA):
      a. Outline the sequence of the Work, equipment to be used, identify hazards that may exist or may be created and what procedures and/or safety equipment will be used to eliminate or reduce these hazards. A Scope of Work JSA shall be prepared and provided to the Engineer prior to the start of unusual,

hazardous, or have risk potential activities on the Project. The name of the competent person assigned to this activity will be included on the JSA.

b. Complete a JSA for any activity, which may be of an unusual nature or involves unique hazards.

4. Reports

a. Provide to Engineer copies of Contractor's and subcontractor's:

1) First aid, recordable, lost time and near miss, monthly logs.
2) OSHA 200 injury log (annually).
3) Safety meeting reports and topics (weekly).
4) List of competent persons as required by OSHA and the Project Health and Safety Manual for each required task and their qualification as such.
5) Injury and accident reports will be submitted to Engineer within 24 hours of any incident. **Immediate** notification to Engineer of an accident is **required**. Full cooperation with Engineer in accident investigation is required.

b. Conduct regular safety inspections according to the Contractor's Safety Plan. Corrective actions shall be taken within 24 hours to address all deficiencies identified during inspections. Deficiency reports shall be prepared and submitted to Engineer within 48 hours indicating corrective actions taken. Failure to comply with required corrective measures identified in the safety inspection will result in the delayed signing of the monthly application for progress payment by Engineer.

c. Provide Engineer with a report of any periodic audit of Contractor's safety performance and/or records.

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SECTION 01 32 00
ELECTRONIC PROJECT MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements to use Engineer's web-based Electronic Project Management system (EPM).

1.2 RELATED SECTIONS

A. Section 01 33 20 – Submittal Procedures

1.3 ADMINISTRATIVE REQUIREMENTS

A. Contractor is required to use Engineer's (EPM) system, VPO, by The Simplex Group, Inc. for electronic construction management document control and communications between the Owner, Engineer, other project-related consultants, and Contractor. Having the system capability in place onsite is a condition precedent to processing the first payment request.

B. User Access Limitations:
   1. Engineer will control access to the EPM system by allowing access and assigning user profiles to accepted personnel.
   2. User profiles will define levels of access into the system, determine assigned function-based authorizations, and user privileges.
   3. Subcontractors and suppliers will be given access to the EPM system by and through Engineer. Entry of information exchanged and transferred between Contractor and subcontractors and suppliers will be the responsibility of Contractor.

C. Ownership and Management of Data:
   1. Data entered in a collaborative mode (entered with the intent to share as determined by permissions and workflows within the EPM system) by all parties will be owned by Engineer, but maintained and operated collaboratively by members of the Project Team.

D. Automated System Notification and Audit Log Tracking:
   1. Review comments made (or lack thereof) by Engineer or Owner on Contractor submitted documentation does not relieve Contractor from compliance with requirements of the Contract Documents.
   2. Contractor is responsible for managing, tracking, and documenting Work to comply with the requirements of the Contract Documents.
   3. Engineer's or Owner's acceptance via automated system notifications or audit logs extends only to the face value of the submitted documentation and does not constitute validation of Contractor's submitted information.

E. Computer Requirements:
   1. Use computer hardware and software that meets the requirements of the EPM system. As recommendations are modified by the EPM system's authors, upgrade hardware and software system(s) to meet or exceed the recommendations.

Upgrading Contractor's computer systems will not be justification for a cost or time modification to the Contract.

2. Ensure that connectivity to the EPM system is accomplished through DSL, cable, T-1, fiber optic, or wireless communications systems. Minimum bandwidth requirements for using the system are 128 kb/s. It is recommended that a faster connection be used when uploading pictures, videos, and data files into the system.
3. Before upgrading any computer software or hardware, verify that such upgrades are compatible with the latest version of the EPM system at no additional cost to the Engineer or Owner.
4. Utilize the full version of Adobe Acrobat (or equal) so that Portable Document Format (PDF) submittals can be assembled into single files and organized appropriately. Obtaining and utilizing this software will be at no additional cost to Engineer or Owner.

F. User Connectivity:
1. Provide a list of Contractor's key EPM personnel for the Engineer's acceptance.
2. Contractor is responsible for identifying personnel to be added or removed from the system.
3. Engineer reserves the right to perform a security check on all potential users.
4. Contractor will be allowed to add additional personnel and subcontractors to the EPM system.

G. Training:
1. Engineer will provide a single training session to assist Contractor in the use of the EPM system. Time cost of the training session will be borne by the attendees.
2. Make applicable staff available for an initial 2-hour training session to be scheduled at a mutually agreeable time and place within 14 days of Notice to Proceed.
3. Training may consist of web-based seminar(s) in conjunction with a conference call.
4. Contractor may request Engineer to provide additional training and technical support for use of the EPM system. Time cost of the training session will again be borne by the attendees.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Web Based EPM User's List:
1. At the preconstruction meeting, provide a list of key EPM personnel, utilizing form at the end of this Section. Engineer will use this information for no other purpose than to establish the necessary accounts for use by each individual.
2. Specifically identify Contractor's administrator on the list.
3. Personnel shall have sufficient computer skills required to access the Internet, log on to the EPM system, and utilize the system.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SYSTEM UTILIZATION

A. Utilize the EPM system to transmit all documents and for all information management required by the Contract Documents.

B. When transmitting electronic documents, use PDF format unless specifically instructed to upload native format document files. When creating PDF files, utilize the native software to produce the most efficient files directly and avoid optically scanning hard copies.

C. Unacceptable documents include faxed and/or hand-written documentation of RFI, sketches, and inspection requests/reports.
   1. Contractor is responsible for data entry via the EPM system in the generation of Project related documentation.
   2. Contractor is responsible for preparing electronic sketches and drawings necessary for the electronic submittal of necessary information related to general questions and formal RFI.
   3. Provide field personnel with the necessary computer equipment to allow entering documentation electronically.

3.2 SYSTEM CONTENTS

A. The EPM system will contain the following information available to Contractor and the Project team in general.

B. Administrative Documents
   1. Submit all general correspondence and pre-construction submittals using the EPM system. Examples include:
      a. Permits
      b. Requests for Substitution per Section 01 25 10 – Products, Materials, Equipment, and Substitutions.
      c. Transmit Construction Schedules in both the native software format and as a PDF file in the format specified herein.
      d. General information requests.
      e. Contractor's Quality Control Plan and associated reports.
      f. Meeting minutes from Project meetings.

C. Requests for Interpretation (RFI): Submit RFI and maintain logs through the EPM system and in accordance with Section 01 26 13 – Requests for Interpretation (RFI).

D. Compliance Submittals
   1. Submit material test reports, inspection requests and reports, certificates, and manufacturer field reports through the EPM system as PDF files.

E. Project Photographs and Videos.
   1. Include dates on photographs and videos.
   2. Use JPEG or JPEG2000 format for photos

3. Use WMV file format for videos.

F. Inspection requests and reports.

G. Record and Closeout Submittals
1. Submit operation and maintenance data and closeout submittals through the EPM system as PDF documents during the approval and review of such, as specified in Section 01 33 20 – Submittal Procedures. Hard copy submittal is required only for final approved documents.

H. Financial Submittals
1. Submit required Schedule of Values, Pay Estimates, and Change Request Proposals through the EPM system.

3.3 OFFICIAL RECORD

A. The documentation and records maintained in the EPM system will be the "Official Records" for the Project. This documentation shall be the records for adjudication of all Project disputes.

END OF SECTION

EPM System User List

Name	Project Role	E-mail Address	Company	Primary Phone	Address	City	State	Zip Code

Attach additional pages as needed

SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 GENERAL

A. Employ a bar chart schedule for the planning and scheduling of all Work required under the Contract Documents.

B. In addition to the scheduling aspect, the same chart shall show an "S" curve for scheduled dollar expenditures versus time.

C. In the process of preparing baseline schedule and monthly updates, consult with all key subcontractors and suppliers to assure concurrence with the feasibility and achievability of planned start dates, sequencing, durations, and completion dates.

1.2 RELATED SECTIONS

A. Section 01 20 00 – Measurement and Payment

1.3 QUALIFICATIONS

A. Demonstrate competence through the submission of a fully compliant Construction Progress Schedule with the initial schedule submission. Upon failure to so demonstrate competence in scheduling, Engineer may direct Contractor to employ the services of a scheduler that can demonstrate competence. Comply with such directives.

1.4 SUBMITTAL PROCEDURES

A. Submittal Requirements
   1. Submit Construction Progress Schedule on a standard drawing sheet, size 24 inches by 36 inches.
   2. The time scale (horizontal) shall be in weeks. The activities shall be listed on the left hand side (vertical).
   3. Break down activities into sufficient detail to show all work activities. The listing from top to bottom shall be in a logical manner of which the Work will be accomplished. Provide space between activities or within bars to allow for marking of actual progress.
   4. Provide a written narrative of the planning logic along with a description of Work and quantities included in each activity of the bar chart schedule.
   5. Duration: The duration indicated for each activity shall be in units of whole working days and shall represent the single best time considering the scope of the Work and resources planned for the activity, including time for holidays and inclement weather. The calendar for the network shall be in calendar days. Except for certain non-labor activities, such as curing concrete or delivering materials, activity durations shall not exceed 14 days, be less than one day, nor exceed $50,000 in value unless otherwise accepted by Engineer.

B. Time of Submittals

1. Submit the bar chart schedule with "S" curves and narrative within fifteen (15) working days after Notice to Proceed for review by Engineer. The schedule submitted shall indicate a project completion date the same as the contract completion date.
2. Submit a copy of the schedule, clearly showing progress made and actual "S" curves, on a two or four week basis depending on the duration of the project and reporting time agreed to in the preconstruction meeting.

C. Acceptance

1. The bar chart schedule and "S" curves, when accepted by Engineer, constitute the Construction Progress Schedule unless a revised schedule is required due to one or more of the following:
   a. Substantial changes in the Work scope.
   b. A change in Contract time.
   c. Delinquency by Contractor that requires a recovery schedule.
2. Owner's review and acceptance of the Construction Progress Schedule is for conformance to the requirements of the Contract Documents only. Review and acceptance by Owner of Contractor's Construction Progress Schedule does not relieve Contractor of any of its responsibility whatsoever for the accuracy or feasibility of the Construction Progress Schedule, or of Contractor's ability to meet interim milestone dates and the Contract completion date, nor does such review and acceptance expressly or impliedly warrant, acknowledge, or admit the reasonableness of the logic and durations of the Construction Progress Schedule.

1.5 SCHEDULE UPDATES

A. The Construction Progress Schedule shall be updated to reflect the as-built conditions of the Work and to accurately forecast the status of incomplete activities. Provide progress reports at each weekly progress meeting, stating actual percent earned versus percent planned. Submit Construction Progress Schedule updates to Engineer with each payment request, including approved changes in the Work and accurately depicting the current status and sequence of all activities.

B. Submit the updated Construction Progress Schedule in the form, sequence, and number of copies requested for the initial schedule.

C. Engineer will review each submitted Construction Progress Schedule update and provide comments within seven days of the submittal. Revise and resubmit the schedule within five days of receipt of comments from Engineer. Engineer will review the re-submittal within five days and provide comments if the schedule update is still unacceptable. Revise and resubmit the schedule within five days of receipt of comments from Engineer.

1.6 PROGRESS MEETINGS AND LOOK-AHEAD SCHEDULES

A. For the weekly progress meetings, submit a look-ahead schedule. This schedule will cover four weeks: the immediate past week, the current week, and the forthcoming two weeks. List all activities from the accepted Construction Progress Schedule, which are complete, are scheduled for Work during the period, are currently planned to be worked, even if out of sequence, and Work which is unfinished but scheduled to be finished. Provide actual start

and completion dates for the Work that has been completed the prior week. Forecast early start and early finish dates for the Work that is in process or upcoming.

B. Identify each activity noted above by activity number corresponding to the accepted Construction Progress Schedule and detailed description of the activity.

C. Deliver the look-ahead schedule to Engineer 24 hours prior to the weekly progress meeting in a format approved by Engineer.

1.7 CONSTRUCTION SCHEDULE REVISIONS

A. Engineer may direct and, if so directed, Contractor shall propose, revisions to the Construction Progress Schedule upon occurrence of any of the following instances:
   1. The actual physical progress of the Work falls more than five percent (5%) behind the accepted Construction Progress Schedule, as demonstrated by comparison to the accepted monthly Construction Progress Schedule updates or as determined by Engineer if a current accepted Construction Progress Schedule does not exist.
   2. Engineer considers milestone or completion dates to be in jeopardy because of "activities behind schedule". "Activities behind schedule" are all activities that have not or cannot be started or completed by the dates shown in the Construction Progress Schedule.
   3. A Change Order has been issued that changes, ads, or deletes scheduled activities, or affects the time for completion of scheduled activities.

B. When instances requiring revision to the Construction Progress Schedule occur, submit the proposed revised Construction Progress Schedule within ten (10) working days after receiving direction from Engineer to provide such schedule. No additional payment will be made for preparation and submittal of proposed revised Construction Progress Schedules. However, if Engineer accepts the proposed revised Construction Progress Schedule, it shall replace and supersede all previous Construction Progress Schedules and substitute for the next monthly Construction Progress Schedule update that would otherwise be required.

C. Revisions to the Construction Progress Schedule shall comply with all of the same requirements applicable to the original schedule.

1.8 SCHEDULE RECOVERY

A. If a revised Construction Progress Schedule accepted by Engineer requires additional manpower, equipment, hours of work or work shifts, or to accelerate procurement of materials or equipment, or any combination thereof, as schedule recovery measures to meet Contract milestones, implement such schedule recovery measures without additional charge to Owner.

1.9 EARLY COMPLETION SCHEDULES

A. Early completion schedules are generally not acceptable to Owner but may be accepted as a convenience to Contractor and under the following conditions.
   1. Submit a specific written request outlining the specific reasons for using the early completion schedule.

2. Acknowledge and agree in writing that the proposed reduction in time represents Project time already paid for by Owner as part of the Bid Price, and available to both Contractor and Owner for the mitigation of impacts to the Project from any source. Contractor is not entitled to any increase in Contract price for failure to achieve the early completion and waives all claim to same.
3. Early completion schedules shall not be based upon or rely on expedited approvals by Owner or Engineer.
4. Early completion schedules must meet all other requirements of the Contract.

B. Revise early completion schedules, which have activities behind schedule, when and as requested by Engineer.

1.10 BASIS OF SCHEDULE NARRATIVES

A. Furnish a basis of schedule narrative to Engineer with each Application for Payment. If the Work falls behind schedule, submit additional narrative at such intervals as Engineer may request.

B. In each narrative, include a summary of progress for the month, description of any current and anticipated delaying factors, a variance analysis for varying activities, impacts on the construction schedule, and proposed corrective actions. Any Work reported complete, but which is not readily apparent to Engineer, must be substantiated with satisfactory evidence.

C. In each narrative, include a list of the activities completed during the preceding month and a list of the activities started during the month but not yet completed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 20
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for submittals required in performance of the Work, including shop drawings, schedules, surveys, reports, samples, plans, lists, drawings, documents, warranties, certifications, findings, programs, manuals, data sheets, or any other item of information required by the Contract Documents to be submitted in accomplishing the Work.

1.2 RELATED SECTIONS

A. Section 01 11 00 - Summary of Work.

B. Section 01 25 10 – Products, Materials, Equipment and Substitutions.

C. Section 01 29 73 – Schedule of Values.

D. Section 01 31 30 – Safety.

E. Section 01 32 00 – Electronic Project Management System.

F. Section 01 32 16 – Construction Progress Schedule.

G. Section 01 41 26 – Permits.

H. Section 01 45 00 - Quality Control.

I. Section 01 77 00 – Project Closeout.

J. Section 01 78 39 – Project Record Documents.

1.3 DEFINITIONS

A. Action Submittal: Written and graphic information submitted by Contractor that requires Engineer's approval for inclusion in the Work.

B. Deferred Submittal: Information in accordance with the applicable Building Code, submitted by Contractor for portions of the design that are to be submitted to permitting agency after the time of permit application and prior to installation of that portion of Work. Deferred Submittals must include Engineer's review documentation stating that submittal has been found to be in general conformance with overall Project design.

C. Informational Submittal: Information submitted by Contractor to represent compliance with Contract Requirements included in the Work, but which are not part of the Work itself.

Informational Submittals must be submitted to Engineer for information and for determination that submitted information is in accordance with Contract requirements.

D. Shop Drawing: The term "Shop Drawing" as used herein shall be understood to include detail design calculations, shop drawings, fabrication and installation drawings, erection drawings, lists, graphs, and similar items.

E. PDF: Abbreviation for "Portable Document Format", used for transmittal of electronic documents.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Whenever submittals are required hereunder, transmit all documents to Engineer in electronic format, via web-based construction management software as specified in Section 01 32 00 – Electronic Project Management System. Contact information for the web-based project management software will be provided upon issuance of the Notice to Proceed.

B. Be responsible for the accuracy, completeness, and coordination of all submittals. Do not delegate this responsibility in whole or in part to any subcontractor. Submittals may be prepared by Contractor, subcontractor, or supplier, but Contractor shall ascertain that each submittal meets the requirements of the Contract and the Project. Ensure that there is no conflict with other submittals and notify Engineer in each case where a submittal may affect the work of another contractor or Owner.

C. Coordination
   1. Ensure coordination of submittals of related crafts and subcontractors.
   2. Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently ahead of performance of related construction activities to avoid delay.
   3. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
   4. Carefully review all submittals prior to submission. Sign and date each transmittal with a direct statement acknowledging that the equipment or material in the submittal meets all the requirements specified or shown in the Contract Documents without exception. No consideration or review of any submittals will be made for any items, which have not been so certified. All non-certified submittals will be returned without action taken, and any delays caused thereby shall be the total responsibility of Contractor. Submittals which cannot bear this certification because they contain an exception or deviation to the Contract Documents shall be so noted in the electronic transmittal and shall only be submitted in accordance with Section 01 25 10 – Products, Materials, Equipment and Substitutions.

D. Processing: Allow sufficient review time so that installation will not be delayed because of the time required to process submittals, including time for resubmittals.
   1. Except as may otherwise be indicated herein, Engineer will return each submittal, with comments noted thereon, within 14 calendar days following receipt by Engineer.

2. For resubmittal, Engineer will be allowed the same review period as for the original submittal.
3. It is considered reasonable that Contractor will make a complete and acceptable submittal to Engineer by the second submission of an item. Owner reserves the right to withhold monies due Contractor to cover additional costs of any review beyond the second submittal.
4. Allow additional time if processing must be delayed for coordination with subsequent submittals. Engineer will promptly advise Contractor when a submittal being processed must be delayed for coordination.
5. If an intermediate submittal is necessary, process the same as the initial submittal.
6. No extension of Contract Time will be authorized resulting from non-compliant submittals or failure to transmit submittals to Engineer sufficiently in advance of the Work to permit processing.
7. If an incomplete submittal is made, the submittal may be returned without review. A complete submittal will contain sufficient data to demonstrate that the items contained therein comply with the Contract Documents, meet the minimum requirements for submittals as described in the Contract Documents, and include all corrections as required from previous submittals.

E. Submittal Schedule
1. Within 30 days of the Notice to Proceed, submit a complete list of anticipated submittals, which includes Specification and Drawing references.
   a. Coordinate submittal schedule with any subcontracts, schedule of values, the list of products, and Contractor's construction schedule.
   b. Prepare schedule in chronological order.
   c. Update the list with "early start" submittal dates within 15 days of submittal of the Construction Progress Schedule.
   d. Update submittal dates whenever the schedule is updated and include any additional submittals identified after the initial submittal in the updates.

F. Unsolicited Submittals: Unsolicited submittals may be returned without being reviewed.

G. Changes in Work: Changes in the Work will not be authorized by submittal review actions. No review action, implicit or explicit, will be interpreted to authorize changes in the Work. Changes will only be authorized by separate written direction from Owner, in accordance with the General Conditions.

1.5 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. Product Data:
1. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams and performance curves. Where Product Data must be specially prepared because standard published data is not suitable for use, submit as "Shop Drawings."
2. Mark each data sheet to show applicable choices and options pertinent to the Project. Where printed Product Data includes information on several products, some of which

are not required for the Project, mark the data sheets to indicate the applicable information. Include the following information:

a. Manufacturer's printed recommendations.
b. Compliance with recognized trade association standards.
c. Compliance with recognized testing agency standards.
d. Application of testing agency labels and seals.
e. Notation of dimensions verified by field measurement.
f. Notation of coordination requirements.

3. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.

B. Samples

1. Whenever in the Specifications, samples are required, submit not less than 3 samples of each item or material to Engineer for acceptance at no additional cost to Owner.
2. Submit full-size, fully fabricated Samples cured and finished as specified and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.
3. Submit samples for acceptance, a minimum of 21 days prior to ordering such material for delivery to the jobsite. Submit in an orderly sequence so that dependent materials or equipment can be assembled and reviewed without causing delays in the Work.
4. Transmit a submittal as a single PDF document with list of samples via the web-based project management software.
5. Individually and indelibly label and tag all samples to indicate all specified physical characteristics and Manufacturer's name for identification. Upon receiving acceptance by Engineer, one set of the samples will be stamped, dated, and returned. One set of samples will be retained by Engineer, and one set of samples will remain at the Project site until completion of the Work.
6. Unless indicated otherwise, all colors and textures of specified items presented in sample submittals shall be from the manufacturer's standard colors and standard materials, products, or equipment lines. If the samples represent non-standard colors, materials, products, or equipment lines and their selection will require an increase in Contract time or Price, clearly indicate this information in the submittal.

C. Shop Drawings

1. Wherever called for in the Contract Documents, or where required by Engineer, transmit an electronic Shop Drawing Submittal to Engineer for review, using the web-based project management software. Whenever required to submit design calculations as part of a Submittal, such calculations shall bear the signature and seal of a professional engineer registered in the appropriate discipline in the state of Utah unless otherwise directed.
2. Organization
    a. Prepare a single shop drawing submittal for each item or class of material or equipment for which submittal is required. At a minimum, separate submittals are required for different Specification Sections except as follows. A single submittal covering multiple sections will not be accepted unless the primary specification references other sections for components. Example: If a pump section references other sections for the motor, protective coating, anchor bolts, local control panel, and variable frequency drive, a single

submittal would be accepted; a single submittal covering vertical turbine pumps and horizontal split case pumps would not be acceptable.

b. Index the components for the submittal and reference the specification sections and paragraph numbers for all components in the description field of the electronic submittal. Relate the submittal components to drawing number, detail number, schedule title, or room number and building name, as applicable.

c. Unless indicated otherwise, terminology and equipment names and numbers used in submittals shall match the Contract Documents.

d. Engineer will assign a single review action to each submittal, which action shall pertain to every part of the submittal as a whole.

e. Disorganized or unclear submittals, which do not meet the requirements specified herein will be returned without review.

3. Format

a. Assemble submittals into a single PDF file for each transmittal. Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on PDF sheets at least 8-1/2" x 11" and no larger than 36" X 48"

b. Where product data from a manufacturer is submitted, clearly mark which model is proposed, with all pertinent data, capacities, dimensions, clearances, diagrams, controls, connections, anchorage, and supports. Present sufficient level of detail for assessment of compliance with the Contract Documents.

c. Assign each Submittal a unique number, including the specification section under which it is submitted. Number all submittals sequentially within the applicable specification section. Original submittals will be assigned a numeric submittal number. Resubmittals shall be numbered with a revision number in addition to the original submittal number.

D. Engineer's Action

1. If submittal is returned to Contractor marked "NO ACTION TAKEN", indicating that the submittal has been received and is being retained for record-keeping purposes. Formal revision and resubmission of said submittal will not be required.

2. If submittal is returned to Contractor marked "NO EXCEPTIONS TAKEN", formal revision and resubmission of said Submittal will not be required and construction may proceed.

3. If submittal is returned to the Contractor marked "MAKE CORRECTIONS NOTED", formal revision and resubmission of said submittal will not be required but construction must proceed according to the review comments included with the submittal.

4. If submittal is returned marked "REVISE AND RESUBMIT", revise said submittal and resubmit. Construction may not proceed.

5. If submittal is returned marked "REJECTED-RESUBMIT", revise said submittal and resubmit. Construction may not proceed.

6. Resubmittal of portions of multi-page or multi-drawing submittals will not be allowed. For example, if a Shop Drawing Submittal that consists of ten drawings contains only one drawing that needs to be amended and resubmitted, the submittal as a whole is deemed as "REVISE AND RESUBMIT", and all ten drawings included in the submittal are required to be resubmitted.

7. On resubmittals, flag any changes made, other than those made or requested by Owner or Engineer.

E. Commence fabrication of an item only after Engineer has reviewed the pertinent submittals and Engineer has assigned action as either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED". Corrections indicated on submittals are considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis for changes to the Contract requirements.

F. Owner's and/or Engineer's review of shop drawing submittals does not relieve Contractor of the responsibility for correctness of details and dimensions and for compliance with the Contract Documents, nor does it relieve the Contractor of the responsibility to coordinate between the different disciplines of construction work. Contractor shall: assume responsibility and risk for misfits due to errors in submittals; be responsible for dimensions and design of adequate connections and details.

G. Deferred Design Submittals: Items noted on the Contract Documents as "Deferred Submittals" must be submitted to Engineer, who will review them and forward them to the building official with a notation indicating that the deferred submittal documents have been reviewed and found to be in general conformance with the design of the Project. Do not install Deferred Submittal items until the deferred submittal documents have been approved by the permitting agency.

H. Test and Evaluation Reports: Submit technical data, test reports, calculations, surveys, and certifications based on field tests and inspections by independent inspection and testing agency and by authorities having jurisdiction.
   1. Reports of results of inspections and tests will not be considered Contract Documents.
   2. Refer to Section 01 45 00 - Quality Control for additional requirements.

1.6 PRECONSTRUCTION CONFERENCE SUBMITTALS

A. At the preconstruction conference referred to in Section 01 11 00 - Summary of Work, submit the following items to Engineer for review:
   1. A preliminary schedule of Shop Drawings, Samples, and proposed Substitute ("Or-Equal") submittals listed in the Bid.
   2. A list of all permits and licenses to be obtained, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit.
   3. A preliminary Schedule of Values in accordance with Section 01 29 73 – Schedule of Values.
   4. A preliminary Construction Project Schedule in accordance with requirements of Section 01 32 16 – Construction Progress Schedule.
   5. The name and qualifications of the Designated Safety Representative in accordance with requirements of Section 01 31 30 - Safety.

1.7 SITE CONDITION SURVEYS

A. Submit the site conditions survey data as required in Section 01 71 30 – Site Conditions Surveys.

1.8 CONSTRUCTION PROGRESS REPORTS

A. Transmit a progress report to Engineer with each Application for Payment. If the Work falls behind schedule, submit additional progress reports at such intervals as Engineer may request.

B. In each progress report, include sufficient narrative to describe any current and anticipated delaying factors, effect on the construction schedule, and proposed corrective actions. Any Work reported complete, but which is not readily apparent to Engineer, must be substantiated with satisfactory evidence.

C. In each progress report, include a list of the activities completed with their actual start and completion dates, a list of the activities currently in progress, and the number of working days required to complete each.

1.9 SURVEY DATA

A. Make available for examination throughout the construction period, all field books, notes, and other data developed while performing the surveys required by the Work and submit all such data to Engineer with documentation required for final acceptance of the Work.

1.10 UTILITY INVESTIGTION

A. Transmit the findings of the utility investigation in accordance with Section 01 71 50 – Protection and Restoration of Existing Facilities.

1.11 QUALITY ASSURANCE/QUALITY CONTROL PLAN

A. Prepare and submit a Quality Assurance/Quality Control Plan for the Work contained in the Contract in accordance with Section 01 41 10 – Quality Control.

1.12 CONTRACTOR DAILY REPORT

A. Submit to Engineer, or designee, a daily report. Upload report not later than 9:00 A.M. of the workday following the report date and include the following:
   1. Day of week, date, Contractor name and Report number.
   2. Summary of work in process (segregated by Contractor and Subcontractor).
   3. Details of work accomplished including quantities of Work installed.
   4. Summary of equipment working and where working.
   5. Summary of manpower by work element and Subcontractor.
   6. Receipt of major equipment or materials.
   7. All required testing performed and, if available, documented results.
   8. Notification of percent of Work delayed by abnormal weather conditions.
   9. Notification of percent of Work delayed by other utility conflicts or conditions.

1.13 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Manual
   1. Submit technical operation and maintenance information for each item of mechanical, electrical and instrumentation equipment in an organized manner in the *Operations*

and Maintenance Manual, written so that it can be used and understood by the Owner's operation and maintenance staff.

2. Furnish initial submittal of the *Operations and Maintenance Manual* to Engineer upon delivery of the respective equipment.
3. Subdivide the *Operations and Maintenance Manual* first by Specification Section number; second, by equipment item; and last, by "Part." Conform "Parts" to the following (as applicable):
    a. Part 1 – Equipment Summary:
        1) Summary: In a summary table, indicate the equipment name, equipment number, and process area in which the equipment is installed.
        2) Form: Furnish an Equipment Summary Form for each item of mechanical, electrical and instrumentation equipment in the Work. Fill in the relevant information on the form and include it in Part 1.
    b. Part 2 – Operational Procedures:
        1) Procedures: Include manufacturer-recommended procedures on the following in Part 2:
            a) Installation
            b) Adjustment
            c) Startup
            d) Location of controls, special tools, equipment required, or related instrumentation needed for operation
            e) Operation procedures
            f) Load changes
            g) Calibration
            h) Shutdown
            i) Troubleshooting
            j) Disassembly
            k) Reassembly
            l) Realignment
            m) Testing to determine performance efficiency
            n) Tabulation of proper settings for all pressure relief valves, low and high- pressure switches, and other protection devices
            o) List of all electrical relay settings including alarm and contact settings
            p) Lubrication.
    c. Part 3 – Preventive Maintenance Procedures:
        1) Procedures: Preventive maintenance procedures shall include all manufacturer-recommended procedures to be performed on a periodic basis, both by removing and replacing the equipment or component, and by leaving the equipment in place.
        2) Schedules: Include recommended frequency of preventive maintenance procedures. Cover lubrication schedules, including lubricant SAE grade, type, and temperature ranges.
    d. Part 4 – Parts List:
        1) Parts List: Furnish a complete parts list, including a generic description and manufacturer's identification number for each part. Include addresses and telephone numbers of the nearest supplier and parts warehouse.

2) Drawings: Include cross-sectional or exploded view drawings with the parts list.

e. Part 5 – Wiring Diagrams:
   1) Diagrams: In this part, include complete internal and connection wiring diagrams for electrical equipment items.

f. Part 6 – Shop Drawings:
   1) Drawings: In this part, include approved shop or fabrication drawings, complete with dimensions.

g. Part 7 – Safety:
   1) Procedures: This part describes the safety precautions to be taken when operating and maintaining the equipment or working near it.

h. Part 8 – Documentation:
   1) Place all equipment warranties, affidavits, and certifications required by the Technical Specifications in this part.

4. Transmit to Engineer, one copy of the *Operations and Maintenance Manual* in digital format. In addition to the digital copy, furnish Engineer with four identical hard copies of the *Operations and Maintenance Manual*. Each set shall consist of one or more volumes, each of which shall be bound in a standard size, 3-ring, loose-leaf, vinyl plastic hard cover binder suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches. Prepare a table of contents indicating all equipment in the manuals. Display the title of each volume on the cover and spine.
5. Submit *Operations and Maintenance Manuals* in final form, not later than the 75 percent of construction completion date. Correct all discrepancies found by Owner or Engineer in the *Operations and Maintenance Manual* within 30 days from the date of written notification.
6. Incomplete or unacceptable *Operations and Maintenance Manuals* at the 75 percent construction completion point constitute sufficient justification to withhold the amount stipulated in paragraph "*Operations and Maintenance Manual* Submittals" of Section 01 70 10 – Project Closeout, from any monies due.

B. Certificates
1. When specified in individual specification sections, submit manufacturers' certificates to Engineer for review as specified.
2. Submit in form of letter or company standard forms, signed by officer of manufacturer.
3. Include the following with each certification
   a. Project name and location.
   b. Contractor's name and address.
   c. Quantity and date or dates of shipment or delivery to which certificate applies.
   d. Manufacturer's name.
   e. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
   f. Certificates may be recent or previous test results on material or product, but must be acceptable to Engineer.

C. Record Documents

1. Prepare and maintain one set of record documents at the Project Site per the requirements of Section 01 78 39 – Project Record Documents. Submit to Engineer at close of Project.

1.14 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Submit list of spare parts information for all mechanical, electrical, and instrumentation equipment. Include the current list price of each spare part. Limit the spare parts list to those spare parts which each manufacturer recommends be maintained by Owner in inventory at the plant site. Each manufacturer or supplier shall indicate the name, address, and telephone number of its nearest outlet of spare parts to facilitate Owner in ordering. Cross-reference all spare parts lists to the equipment numbers designated in the Contract Documents. In addition to electronic submittal, bind the spare parts lists in standard size, 3-ring, loose-leaf, vinyl plastic hard cover binders suitable for bookshelf storage. Binder ring size not to exceed 2.5 inches.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 35 53
SECURITY

GENERAL

1.1 SUMMARY

A. Protect the active construction areas of the Work, including all material, equipment, field office trailers, and their contents from theft, vandalism, and unauthorized entry.

B. Provide continuous security at active construction site.

1.2 DEFINITIONS

A. For the purposes of this Section, an "active construction area" is any area where construction activities are occurring or construction activities could be considered a potential hazard to people.

1.3 RELATED SECTIONS

A. Section 01 57 19 – Temporary Environmental Controls

1.4 SUBMITTALS

A. Prior to performance of any work at the Project Site, submit to Engineer for record only, two copies of the security plan commensurate with the needs of the Project, signed by officer of Contractor. Be solely responsible for adequacy of the security plan.

B. Provide Engineer with drawing and data showing temporary fencing and gate locations, along with materials to be used.

C. Provide Engineer with a list of 24-hour emergency phone numbers for Contractor personnel.

D. Submit to Engineer an updated progressive inventory of materials and equipment received on-site.

E. Submit log of workmen and visitors to Project Site.

1.5 SECURITY PROGRAM

A. Protect Work and existing premises, including the field office trailers and their contents, from theft, vandalism, and unauthorized entry during working and non-working hours.

B. Accept sole responsibility for Project Site security and protection of the Work.

C. Initiate the security program at job mobilization and maintain the security program throughout construction period.

D. Limit lighting to basic safety and security requirements, and shield when possible.

E. Be responsible for the security of storage compound and lay down area, and for all plant material, equipment, and tools at all times.

F. Prohibit firearms for the Project Site.

G. Prohibit dogs from the Project Site, with the exception of those clearly used for security purposes within fenced areas.

H. Erect and maintain temporary security fencing as required to protect the Work, the Project Site, and existing facilities on the Project Site. The location of all temporary security fencing shall be approved in advance by Engineer. Fencing shall be:
   1. Height: 6ft
   2. Material: Galvanized chain-link

1.6 ENTRY CONTROL

A. Entry control shall not unreasonably limit the personnel of Owner, Engineer, and their operations and maintenance groups from performing assigned duties. Temporary access limitations will be identified to Engineer and the operations and maintenance groups at least 24 hours prior to such limitation.

B. Restrict entry of unauthorized persons and vehicles into Project Site.

C. Allow entry only to authorized persons with proper identification.

D. Maintain a log of workmen and visitors and make log available to Owner on request. This log shall be submitted to Engineer biweekly or as necessary.

E. Require all visitors to sign the visitor log acknowledgment of the project rules included in this Section. A copy of the project rules shall be given to each visitor. Submit copies of these forms to Engineer biweekly.

F. Contractor has the right to refuse access to the Project Site or require that a person or vehicle be removed from the Project Site if found violating any of the project rules.

G. Give jobsite security orientation training to all affected employees, including subcontractor employees. Employee participation in the security orientation shall be acknowledged by their respective individual signatures affixed to an orientation roster.

PRODUCTS (NOT USED)

EXECUTION (NOT USED)

END OF SECTION

SECTION 01 41 26
PERMITS

PART 1 - GENERAL

1.1 ADMINISTRATIVE REQUIREMENTS

A. Obtain permits required for the execution of Work in accordance with the Contract Documents. Provide copies of these permits to Owner.

B. The intent of this Section is to furnish the known list of required permits for the Work under the Contract Documents. Owner does not guarantee that this list is complete. Be responsible for determining and verifying the extent of all permits required and for obtaining such permits.

C. In the Bid Price, include costs for obtaining all necessary permits, including application fees and other costs, and the costs of complying with the conditions of all permits. Any fees listed in this section are estimates and are for information only. Verify and pay all actual fees.

D. Within 30 Days of the Limited Notice to Proceed, submit a list of all permits and licenses to be obtained, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit.

1.2 SUMMARY OF PERMITS TO BE OBTAINED BY CONTRACTOR

A. Obtain the following permits. Submit copies of these permits to Engineer and maintain copies on-site. Comply with all conditions of the permits.
   1. Utah Occupational Safety and Health Administration:
      a. Construction Permit: Covers worker safety and health for all project features.
   2. Utah Department of Environmental Quality, Division of Water Quality:
      a. UPDES General Permit for Construction Dewatering/Hydrostatic Testing of Pipelines: Covers discharge waters associated with dewatering operations and hydrostatic testing of pipelines.
         1) Agency: Utah Department of Environmental Quality, Division of Drinking Water
         2) Contact Person: Harry Campbell
         3) Telephone No.: (801) 538-6923
         4) Email: hcampbell@utah.gov
      b. Notification of Chlorinated Water Discharge: This notification provides 30 days notice prior to disinfection of pipeline and discharge of pipeline and discharge of chlorinated water.
   3. Utah Division of Environmental Protection, Bureau of Water Pollution Control
      a. Temporary Groundwater Discharge Permit is necessary if groundwater is present.
   4. Utah Division of Environmental Protection, General Storm Water Permit for Construction Activities:
      a. As a condition of contract award, sign a certification of agreement to comply with the terms and conditions of the permit. Permit not required if area of disturbance is less than one acre.

b. Agency and Contact Person:
   1) Agency: Utah Department of Environmental Quality, Division of Drinking Water
   2) Contact Person: Tom Rushing
   3) Address: 288 North 1460 West (Cannon Building) 3rd Floor, PO Box 144870, Salt Lake City, Utah 84114-4870
   4) Telephone No.: (801) 538-6951
   5) Email: trushing@utah.gov

5. Utah State Division of Health:
   a. Letter of Approval to Construct: Letter and Certificate are required for construction and operations of a water supply system.
6. Wasatch County
   a. Building and Excavation Permit: Permit is for construction in unincorporated Wasatch County.
      1) Agency: Wasatch County
      2) Contact: Planning and Development
      3) Address:
      4) Telephone No.
   b. Contractor shall obtain the building permit, the Owner shall directly pay to the County all fees associated with this permit.

1.3 SUMMARY OF PERMITS OBTAINED BY OWNER

A. The following permits have been or will be obtained by Owner for this Project. Verify and comply with conditions of said permits.
1. Utah Department of Environmental Quality, Division of Drinking Water
   a. Project Notification Form and Plan Review/Construction Approval
      1) Agency: Utah Department of Environmental Quality, Division of Drinking Water
      2) Contact Person: Julie Cobleigh
      3) Telephone No.: (385) 214-9770
      4) Email: jjcobleigh@utah.gov

END OF SECTION

SECTION 01 42 13
ABBREVIATIONS OF INSTITUTIONS

PART 1 - GENERAL

1.1 GENERAL

A. Wherever in the Contract Documents, references are made to the standards, specifications, or other published data of the various international, national, regional, or local organizations, such organizations may be referred to by their acronym or abbreviation only. As a guide to the reader, the following acronyms or abbreviations which may appear in the Contract Documents shall have the meanings indicated herein.

1.2 ABBREVIATIONS

AAMA	Architectural Aluminum Manufacturer's Association
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AFBMA	Anti-Friction Bearing Manufacturer's Association, Inc.
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AI	The Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute, Inc.
APA	American Plywood Association
API	American Petroleum Institute
APWA	American Public Works Association

ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASLE	American Society of Lubricating Engineers
ASME	American Society of Mechanical Engineers
ASQC	American Society for Quality Control
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturer's Association
CGA	Compressed Gas Association
CLFMI	Chain Link Fence Manufacturer's Institute
CLSI	Clinical and Laboratory Standards Institute
CRSI	Concrete Reinforcing Steel Institute
EIA	Electronic Industries Association
ETL	Electrical Test Laboratories
EPA	Environmental Protection Agency
FM	Factory Mutual System
FPL	Forest Products Laboratory
HI	Hydronics Institute
IAPMO	International Association of Plumbing and Mechanical Officials
IBC	International Building Code
ICC	International Code Council
ICEA	Insulated Power Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers

IES	Illuminating Engineering Society
IP	Institute of Petroleum (London)
IPC	Institute of Printed Circuits
ISA	Instrument Society of America
ISO	International Organization for Standardization
ITE	Institute of Traffic Engineers
MBMA	Metal Building Manufacturer's Association
MPTA	Mechanical Power Transmission Association
MSS	Manufacturers Standardization Society
MTI	Marine Testing Institute
NAAMM	National Association of Architectural Metal Manufacturer's
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards
NCMA	National Concrete Masonry Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NLGI	National Lubricating Grease Institute
NSF	NSF International
NWMA	National Woodwork Manufacturers Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PPI	Plastics Pipe Institute
RWMA	Resistance Welder Manufacturer's Association
SAE	Society of Automotive Engineers

SAMA	Scientific Apparatus Makers Association
SMACCNA	Sheet Metal and Air Conditioning Contractors National Association
SPI	Society of the Plastics Industry, Inc.
SPR	Simplified Practice Recommendation
SSPC	Society for Protective Coatings
SSPWC	Standard Specifications for Public Works Construction
TIA	Telecommunications Industry Association
UL	Underwriters Laboratories, Inc.
WEF	Water Environment Federation
WRI	Wire Reinforcement Institute, Inc.
WWPA	Western Wood Products Association
WWPA	Western Wood Products Association (WWPA)

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 42 19
REFERENCE STANDARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Titles of Sections and Paragraphs: Captions accompanying Specification Sections and Paragraphs are for convenience of reference only, and do not form a part of the Specifications.

B. Applicable Publications: Whenever in these Specifications, references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is specified, only the latest specifications, standards, or requirements of the respective issuing agencies, which have been published as of the date that the Work is advertised for bids, shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth herein or shown on the Drawings shall be waived because of any provision of, or omission from, said standards or requirements.

C. Specialists, Assignments: In certain instances, Specification text requires (or implies) that specific Work is to be assigned to specialists or expert entities, who must be engaged for the performance of that Work. Such assignments shall be recognized as special requirements with no choice or option. These requirements shall not be interpreted so as to conflict with the enforcement of building codes and similar regulations governing the Work; also they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of Work is recognized as "expert" for the indicated construction processes or operations. Nevertheless, accept the final responsibility for fulfillment of the entire set of contract requirements.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of the Specifications, all Work specified herein shall conform to or exceed the requirements of applicable codes and the applicable requirements of the following documents.

B. References herein to "Building Code", “Plumbing Code”, “Mechanical Code”, “Fuel Gas Code”, or “Fire Code” shall mean the latest adopted version of the International Building Code (IBC), the International Plumbing Code (IPC), the International Mechanical Code (IMC), the International Fuel Gas Code (IFGC), and the International Fire Code (IFC) as published by the International Code Council (ICC). Similarly, references to the "Uniform Mechanical Code" or the "Uniform Plumbing Code" shall mean the Uniform Mechanical Code or the Uniform Plumbing Code as published by the International Association of Plumbing and Mechanical Officials (IAPMO) References to the "Electric Code" or "National Electric Code (NEC)" shall mean the National Electric Code of the National Fire Protection Association (NFPA). The latest edition of any “building” code as approved by the Municipal Code and adopted by the authority having jurisdiction, shall apply to the Work herein, including all addenda, modifications, amendments, or other lawful changes thereto.

C. In case of conflict between codes, reference standards, Drawings and the other Contract Documents, the most stringent requirements shall govern. Bring all conflicts to the attention of Engineer for clarification and directions prior to ordering or providing any materials or furnishing labor. Bid the most stringent requirements.

D. Construct the Work indicated herein in accordance with the requirements of the Contract Documents and the referenced portions of those referenced codes, standards, and specifications listed herein.

E. Applicable Standard Specifications: References in the Contract Documents to the "Standard Specifications" shall mean the *Manual of Standard Specifications* (APWA), latest version.

F. References herein to "OSHA Regulations for Construction" shall mean *Title 29, Part 1926, Construction Safety and Health Regulations*, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

G. References herein to "OSHA Standards" shall mean *Title 29, Part 1910, Occupational Safety and Health Standards*, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

H. References herein to “UDOT Standards” shall mean *Standard Specifications for Road and Bridge Construction*.

I. References herein to “MSHA Standards” shall mean *Mine Safety and Health Administration Standards*, latest version.

1.3 REGULATIONS RELATED TO HAZARDOUS MATERIALS

A. Be responsible that all Work included in the Contract Documents, regardless if shown or not, complies with all EPA, OSHA, RCRA, NFPA, and any other Federal, State, and Local Regulations governing the storage and conveyance of hazardous materials, including petroleum products.

B. Where no specific regulations exist, all chemical, hazardous, and petroleum product piping and storage in underground locations must be installed with double containment piping and tanks, or in separate concrete trenches and vaults, or with an approved lining which cannot be penetrated by the chemicals, unless waived in writing by Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 45 00
QUALITY CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. The requirements of this Section apply to, and are a component part of, each Section of the Specifications.

1.2 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM D3740	Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D3666	Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 20 –Submittal Procedures.

B. Submit Quality Control Plan.

C. Submit credentials for field Quality Control Representative showing experience acceptable to Engineer.

D. Submit credentials for testing laboratory showing compliance with Specifications and acceptable to Engineer.

E. Submit results of testing as specified below.

1.4 SITE INVESTIGATION AND CONTROL

A. Check and verify all dimensions and conditions in the field continuously during construction. Be solely responsible for any inaccuracies built into the Work due to Contractor's (including Subcontractor's) failure to comply with this requirement.

B. Inspect related and appurtenant Work and report in writing to Engineer, any conditions which will prevent proper completion of the Work. Failure to report any such conditions constitutes acceptance of all Site conditions. Required removal, repair, or replacement caused by unsuitable conditions shall be performed at no additional cost to Owner.

1.5 INSPECTION OF THE WORK

A. Inspect all Work performed by the both Contractor and Subcontractors. Nonconforming Work and any safety hazards in the work area shall be noted and promptly corrected. Be responsible for the Work to be performed safely and in conformance with the Contract Documents.

B. The Work shall be conducted under the general observation of Engineer and is subject to inspection by representatives of Owner acting on behalf of Owner to ensure strict compliance with the requirements of the Contract Documents. Such inspection may include mill, plant, shop, or field inspection, as required. Owner, Engineer, or any inspector(s) shall be permitted access to all parts of the Work, including plants where materials or equipment are manufactured or fabricated.

C. The presence of Engineer, or any inspector(s), shall not relieve Contractor of responsibility for the proper execution of the Work in accordance with all requirements of the Contract Documents. Compliance is the responsibility of Contractor. No act or omission on the part of Engineer, or any inspector(s) shall be construed as relieving Contractor of this responsibility. Inspection of Work later determined to be nonconforming shall not be cause or excuse for acceptance of the nonconforming Work. Owner may accept nonconforming Work when adequate compensation is offered and it is in Owner's best interest as determined solely by Owner.

D. All materials and articles furnished shall be subject to rigid documented inspection by qualified personnel. No materials or articles shall be used in the Work until they have been inspected and accepted by Contractor's Quality Control Representative and Engineer or other designated representative. No Work shall be backfilled, buried, cast in concrete, covered, or otherwise hidden until it has been inspected. Any Work covered in the absence of inspection shall be subject to uncovering. Where uninspected Work cannot be easily uncovered, such as in concrete cast over reinforcing steel, all such Work shall be subject to demolition, removal, and reconstruction under proper inspection.

E. All Owner furnished materials and articles shall be subject to rigid inspection by Contractor's Quality Control Representative before being used or placed in the Work. Inform Engineer, in writing, of the results of said inspections within one working day after completion of inspection. In the event that any material or articles provided by Owner are considered to be of insufficient quality for use in the Work, immediately notify Engineer.

1.6 TIME OF INSPECTION AND TESTS

A. Furnish and prepare samples and test specimens required under these Specifications and for testing in ample time for the completion of the necessary tests and analyses before said articles or materials are to be used. Furnish and prepare all required test specimens without additional expense to Owner. As provided in the Contract Documents, performance of certain tests will be by Owner, and all costs therefore will be borne by Owner, except that the costs of any test, which shows unsatisfactory results shall be back charged to Contractor.

B. Notify Engineer at least three Work Days before being ready to backfill, bury, cast in concrete, hide, or otherwise cover any Work under this Contract and request inspection before

beginning any such Work of covering. Failure to notify Engineer at least three Work Days in advance of any such inspections shall be reasonable cause for Engineer to order a sufficient delay in scheduled operations to allow time for such inspection. Be responsible for costs of any remedial or corrective work required, and all costs of such delays, including its impact on other portions of the Work.

1.7 SAMPLING AND TESTING

A. Unless otherwise specified, all sampling and testing shall be in accordance with the methods prescribed in the current standards of the ASTM, as applicable to the class and nature of the article or materials considered. However, Engineer reserves the right to use any generally-accepted system of inspection which, in the opinion of Engineer, will ensure Engineer that the quality of the workmanship is in full accord with the Contract Documents.

B. Owner reserves the right to waive tests or quality control measures. However, waiver of any specific testing or other quality control measure, whether or not such waiver is accompanied by a guarantee of substantial performance as a relief from the specified testing or other quality control requirements as originally specified, and whether or not such guarantee is accompanied by a performance bond to assure execution of any necessary corrective or remedial work, shall not be construed as a waiver of any technical or qualitative requirements of the Contract Documents.

C. Notwithstanding the existence of such waiver, Owner reserves the right to make independent investigations and tests as specified in the following paragraph and failure of any portion of the Work to meet qualitative requirements of the Contract Documents shall be reasonable cause for Owner to require the removal or correction and reconstruction of any such Work.

D. In addition to any other inspection or quality control provisions that may be specified, Owner reserves the right to independently select, test, and analyze, at the expense of Owner, additional test specimens of any or all of the materials to be used. Results of such additional tests and analyses shall be considered along with the tests or analyses made by the Contractor to determine compliance with the applicable specifications for the materials so tested or analyzed provided that wherever any portion of the Work is discovered, as a result of such independent testing or investigation by Engineer, which fails to meet the requirements of the Contract Documents, all costs of such independent inspection and investigation and all costs of removal, correction, reconstruction, or repair of any such Work shall be borne by Contractor.

1.8 RIGHT OF REJECTION

A. Engineer or designated representative, acting for Owner, reserves the right at all times and places to reject any articles or materials furnished hereunder which, in any respect, fail to meet the requirements of the Contract Documents, regardless of whether the defects in such articles or materials are detected at the point of manufacture or after completion of the Work at the Site. If Engineer or designated representative, through an oversight or otherwise, has accepted materials or Work which are defective or in any way contrary to the Contract Documents, such materials, no matter in what stage or condition of manufacture, delivery, or erection, may be rejected.

B. Promptly remove or replace rejected articles or materials from the Site of the Work after notification of rejection.

C. Bear all costs of removal and replacement of rejected articles or materials.

D. Failure to promptly remove and replace rejected Work shall be considered a breach of this Contract and Owner may, after 7 days' notice, terminate Contractor's right to proceed with the affected Work and remove and replace the Work and issue a backcharge to cover the cost of the Work.

1.9 QUALITY CONTROL REQUIREMENTS

A. Establish and execute a Quality Control program for the services, which are being provided. The program shall provide adequate measures for verification and conformance to defined requirements of all personnel, including lower-tier subcontractors (including fabricators, suppliers, and sub-subcontractors). Prepare and submit a plan responsive to this Section for review by Engineer.

B. Furnish Engineer with a project specific Quality Control Plan. The plan shall contain a comprehensive account of quality control procedures applicable to this Project. The detailed requirements for this Plan are delineated in the following paragraphs. No progress payments will be made until the Quality Control Plan is fully accepted by Engineer.

C. Using the Quality Control Plan, describe and define the personnel requirements described herein. Provide personnel with assigned quality control functions reporting to a field Quality Control Representative. The field Quality Control Representative shall report to a senior manager of Contractor and shall not have supervisory or managerial responsibility over the work force. Persons performing quality control functions shall have sufficient qualifications, authority, and organizational freedom to identify quality problems and to initiate and recommend solutions. Contractor's Quality Control representative(s) shall be on-site as often as necessary (but not less than the daily hours specified in the Contract Documents) to remedy and demonstrate that Work is being performed properly and to make multiple observations of all Work in progress. The Quality Control Plan shall include a statement by the senior manager designating the Quality Control Representative and specifying authorities delegated to the Quality Control Representative to direct cessation or removal and replacement of defective Work.

D. The Quality Control Plan shall ensure the achievement of adequate quality throughout all applicable areas of the contract. In the Quality Control Plan, describe the program and include procedures, work instructions and records. In addition, describe methods relating to areas that require special testing and procedures as noted in the Specifications.

E. Identification and Control of Items and Materials: Describe procedures in the Quality Control Plan to ensure that items or materials that have been accepted at the site are properly used and installed. Provide procedures for proper identification and storage, and to prevent the use of incorrect or defective materials.

F. Inspection and Tests: Provide written procedures defining a program for control of inspections performed. These procedures shall be described in the Quality Control Plan.

1. Inspections and tests shall be performed and documented by qualified individuals. At a minimum, "qualified" shall mean having performed similar quality control functions on similar type projects. Records of personnel experience, training and qualifications shall be maintained and made available for review by Engineer upon request.
2. Maintain and provide to Engineer, within two working days of completion of each inspection and test, adequate records of all such inspections and tests. Inspection and test results shall be documented and evaluated to ensure that requirements have been satisfied.
3. Procedures shall include:
    a. Specific instructions defining procedures for observing all Work in process and comparing this Work with the Contract requirements (organized by specification section).
    b. Maintaining and providing Daily Inspection Reports. Such reports shall, at a minimum, include the following:
        1) Item(s) inspected
        2) Quality characteristics in compliance
        3) Quality characteristics not in compliance
        4) Corrective/remedial actions taken
        5) Statement of certification
        6) QC Manager's signature
    c. Specific instructions for recording all observations and requirements for demonstrating through the reports that the Work observed was in compliance or a deficiency was noted and action to be taken.
    d. Procedures to preclude the covering of deficient or rejected Work.
    e. Procedures for halting or rejecting Work.
    f. Procedures for resolution of differences between the Quality Control Representative(s) and the production representative(s).
4. The Quality Control Plan shall identify all contractual hold/inspection points as well as any Contractor imposed hold/inspections points.
5. The Quality Control Plan shall include procedures to provide verification and control of all testing provided, including:
    a. Maintaining and providing to Engineer Daily Testing Records. Such records shall, at a minimum, contain the following:
        1) Item(s) tested
        2) Quality characteristics in compliance
        3) Statement of correctness & certification
        4) Quality characteristics not in compliance
        5) Corrective/remedial actions taken
        6) QC Manager's signature
    b. Individual test records will contain the following information:
        1) Item tested –item number and description
        2) Test results
        3) Test designation
        4) Test work sheet including location sample was obtained
        5) Acceptance or rejection
        6) Date sample was obtained
        7) Retest information, if applicable
        8) Control requirements
        9) Tester signature

10) Testing QC staff initials

c. Providing for location maps for all tests performed or location of Work covered by the tests.

d. Maintaining copies of all test results.

e. Ensuring Engineer receives independent copy of all tests.

f. Ensuring testing lab(s) are functioning independently and in accordance with the specifications.

g. Ensuring re-tests are properly taken and documented.

G. Control of Measuring and Test Equipment: Measuring and/or testing instruments shall be adequately maintained, calibrated, and adjusted to maintain accuracy within prescribed limits. Perform calibration at specified periods against valid standards traceable to nationally recognized standards and documented.

H. Supplier Quality Assurance: The Quality Control Plan shall include procedures to ensure that procured products and services conform to the requirements of the Contract Documents. Requirements of these procedures shall be applied, as appropriate, to lower-tier suppliers and/or Subcontractors.

I. Deficient and Nonconforming Work and Corrective Action: The Quality Control Plan shall include procedures for handling of deficiencies and non-conformances. Deficiencies and non-conformances are defined as documentation, drawings, material, equipment, and Work not conforming to the specified requirements or procedures. The procedure shall prevent non-conformances by identification, documentation, evaluation, separation, disposition and corrective action to prevent recurrence. Conditions having adverse effects on quality shall be promptly identified and reported to the senior level management. The cause of conditions adverse to quality shall be determined and documented and measures implemented to prevent recurrence. In addition, at a minimum, this procedure shall address:

1. Personnel responsible for identifying deficient and non-complying items within the work.
2. How and by whom deficient and non-compliant items are documented “in the field”.
3. The personnel and process utilized for logging deficient and non-compliant work at the end of each day onto a Deficiency Log.
4. Tracking processes and tracking documentation for deficient and non-compliant items.
5. Personnel responsible for achieving resolution of outstanding deficiencies.
6. Once resolved, how are the resolutions documented and by whom.

J. Special Processes and Personnel Qualifications

1. The Quality Control Plan shall include detailed procedures for the performance and control of special process (e.g. welding, soldering, heat treating, cleaning, plating, nondestructive examination, etc.).
2. Personnel performing special process tasks shall have the experience, training and certifications commensurate with the scope, complexity, or nature of the activity. They shall be approved by Engineer before the start of Work on the Project.

K. Audits: The Quality Control Plan shall provide for documented audits to verify that quality control procedures are being fully implemented by Contractor as well as its subcontractors. Audit records shall be made available to Engineer upon request.

L. Documented Control/Quality Records

1. Establish methods for control of Contract Documents, which describe how Drawings and Specifications are received and distributed to assure the correct issue of the document being used. The methods shall also describe how as-built data are documented and furnished to Engineer.
2. Maintain evidence of activities affecting quality, including operating logs, records of inspections and tests, audit reports, material analyses, personnel qualification and certification records, procedures, and document review records.
3. Quality records shall be maintained in a manner that provides for timely retrieval, and traceability. Quality records shall be protected from deterioration, damage, and destruction.
4. Provide a list with specific records as specified in the Contract Documents, which will be furnished to Engineer at the completion of activities.

M. Acceptance of Quality Control Plan: Engineer's review and acceptance of the Quality Control Plan shall not relieve Contractor from any of its obligations for the performance of the Work. Contractor's quality control staffing is subject to Engineer's review and continued acceptance. Owner, at its sole option, without cause, may direct Contractor to remove and replace the Quality Control Representative. No Work covered by the Quality Control Plan shall start until Engineer's acceptance of the Quality Control Plan has been obtained.

N. Engineer may perform independent quality assurance audits to verify that actions specified in the Quality Control Plan have been implemented. No Engineer audit finding or report shall in any way remove any requirements of this Contract.

1.10 TESTING SERVICES

A. All tests which require the services of a laboratory to determine compliance with the Contract Documents shall be performed by an independent commercial testing firm acceptable to Engineer. The testing firm's laboratory shall be staffed with experienced technicians, properly equipped and fully qualified to perform the tests in accordance with the specified standards.

B. Independent testing laboratory shall be accredited by the American Association of State Highway and Transportation Officials (AASHTO) for the tests they will perform and as appropriate for the Work being performed. The laboratory shall also be accredited under ASTM C1077, ASTM D3740, and ASTM D3666.

C. Engineer shall have the right to inspect work performed by the independent testing laboratory both at the project and at the laboratory. This shall include inspection of the independent testing laboratory's internal quality assurance records (quality assurance manual, equipment calibrations, proficiency sample performance, etc.).

D. Obtain Engineer's acceptance of the testing firm before having services performed. Pay all costs for these testing services.

E. Testing services provided by Owner, if any, are for the sole benefit of Owner. However, test results shall be available to Contractor. Testing necessary to satisfy Contractor's internal quality control procedures shall be the sole responsibility of Contractor.

F. Testing Services furnished by Contractor: Unless otherwise specified, and in addition to all other specified testing requirements, provide all testing services in connection with the following materials as required for Engineer's review:
   1. Concrete materials and mix designs.
   2. Embankment, fill, and backfill materials.
   3. Quality control testing of all precast concrete.
   4. Moisture-density and relative density tests on fill and backfill materials.
   5. In-place field density test on fills and backfill.
   6. All other tests and engineering data required for Engineer's review of materials and equipment proposed to be used in the Work.
   7. In addition, the following quality control tests shall be performed by Contractor:
      a. Holiday testing of pipeline coatings.
      b. Air testing of field-welded joints for steel pipe or pipe cylinders and fabricated specials.
      c. All testing and inspection of welding work including, but not limited to, welding procedure qualifications, welder operator qualifications, all work performed by the certified welding inspector, all appropriate nondestructive testing of welds and all repair and retest of weld defects.

G. Testing Services furnished by Owner: Unless otherwise specified, Owner will provide quality control testing services in connection with the following materials and equipment incorporated in the Work;
   1. Concrete strength tests.
   2. Other materials and equipment as specified herein.
   3. Testing, including sampling, shall be performed by Engineer or testing firm's laboratory personnel, in general manner and frequency indicated in the Specifications.
   4. Furnish all sample materials and cooperate in the testing activities, including sampling. Interrupt the Work when necessary to allow testing, including sampling to be performed. There shall be no claim for an increase in Contract Price or Contract Times due to such interruption. When testing activities, including sampling, are performed in the field by the testing firm's laboratory personnel, furnish personnel and facilities to assist in the activities.
   5. The testing firm's laboratory shall perform all laboratory tests within a reasonable time consistent with the specified standards and will furnish a written report of each test. Distribution of the reports shall be as directed by Engineer.

H. Transmittal of Test Reports: Written reports of tests and engineering data furnished for Engineer's review of materials and equipment proposed to be used in the Work shall be submitted per Section 01 33 20 Contractor Submittals.

I. The testing firm retained for material field testing shall furnish a minimum of five copies of written report of each test. Three copies of each test report will be transmitted to Engineer within three Work Days after each test is completed. Consecutively number each report for each type of test.

J. Testing firm shall furnish one copy of each field and laboratory quality control test to Contractor.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 50 10
SITE ACCESS AND STORAGE

PART 1 - GENERAL

1.1 REFERENCES

A. U.S. Dept. of Transportation, Federal Highway Administration (FHWA) standards.

MUTCD	Manual of Uniform Traffic Control Devices

B. U.S. Dept. of Labor, Occupational Safety and Health Administration (OSHA) standards.

Subpart G, Part 1926	Safety and Health Standards for Construction

1.2 SUBMITTALS

A. Provide design and engineering calculations for custom temporary bridges or steel plates to be employed.

B. Submit hazardous materials storage plan.

C. Submit the EPA issued number for wastes generated at the site.

1.3 ROADWAY AND TRAFFIC LIMITATIONS

A. Investigate the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress to the site of the Work. Comply with the provisions specified in the Traffic Management Plan. Accept responsibility to construct and maintain any haul roads required for construction operations.

B. Maintain a maximum speed limit of 25 mph while on the Project Site.

C. Confine all vehicles to the designated construction area. Cross-country travel is prohibited.

1.4 TEMPORARY CROSSINGS

A. General: Provide continuous, unobstructed, safe, and adequate pedestrian and vehicular access to fire hydrants, commercial and industrial establishments, churches, schools, parking lots, service stations, motels, fire and police stations, and hospitals. Provide safe and adequate public transportation stops and pedestrian crossings at intervals not exceeding 300 feet. Cooperate with parties involved in the delivery of mail and removal of trash and garbage to maintain existing schedules for such services. Maintain vehicular access to residential driveways to the property line except when necessary construction precludes such access for reasonable periods of time.

B. Temporary Bridges: Wherever necessary, provide suitable temporary bridges or steel plates over unfilled excavations, except where written consent of the individuals or authorities

concerned to omit such temporary bridges or steel plates has been secured. Any such obtained written consent shall be delivered to Engineer prior to excavation. Maintain all such bridges or steel plates in service until access is provided across the backfilled excavation. Temporary bridges or steel plates for street and highway crossing shall conform to the requirements of the authority having jurisdiction in each case. Adopt designs furnished by said authority for such bridges or steel plates, or submit designs to said authority for approval, as may be required. New designs shall be stamped and signed by a professional engineer, licensed to practice in the State which the work is taking place.

C. Street Use: Nothing herein shall be construed to entitle Contractor to the exclusive use of any public street, alleyway, or parking area during the performance of the Work hereunder. Conduct operations so as not to interfere unnecessarily with the authorized work of utility companies or other agencies in such streets, alleyways, or parking areas. No street shall be closed to the public without first obtaining permission of Engineer and proper governmental authority. Where excavation is being performed in primary streets or highways, maintain one lane in each direction open to traffic at all times unless otherwise indicated. Provide toe boards to retain excavated material if required by Engineer or the agency having jurisdiction over the street or highway. Fire hydrants on or adjacent to the Work shall be kept accessible to fire-fighting equipment at all times. Temporary provisions shall be made to assure the use of sidewalks and the proper functioning of all gutters, storm drain inlets, and other drainage facilities.

D. Traffic Control: For the protection of traffic in public or private streets and ways, provide, place, and maintain all necessary barricades, traffic cones, warning signs, lights, and other safety devices in accordance with the requirements of the MUTCD, Part VI - Traffic Controls for Street and Highway Construction and Maintenance Operations."

E. Take all necessary precautions for the protection of the Work and the safety of the public. All barricades and obstructions shall be illuminated at night, and all lights shall be kept burning from sunset until sunrise. Station such guards or flaggers and conform to such special safety regulations relating to traffic control as may be required by the public authorities within their respective jurisdictions. All signs, signals, and barricades shall conform to OSHA Safety and Health Standards for Construction.

F. Temporary Street Closure: If closure of any street is required during construction, apply in writing to the authority having jurisdiction at least 30 days in advance of the required closure for signage and detour requirements.

G. Temporary Driveway Closure: Notify property owner or occupant (if not owner-occupied) of the closure of the driveways to be closed more than one eight-hour work day at least three working days prior to the closure. Minimize the inconvenience and minimize the time period that the driveways will be closed. Fully explain to the owner/occupant how long the work will take and when closure is to start.

1.5 WORK AND STORAGE AREA

A. Owner will designate as indicated in the Contract Documents, and arrange for the Contractor's use, a portion of the property for use during the term of the Contract as a storage

and shop area for construction operations on the Work. Provide a plot plan of intended storage/work area use to Engineer.

B. Make independent arrangements for any necessary off-site storage or shop areas necessary for the proper execution of the Work.

C. Lands to be furnished by Owner for construction operation and other purposes are indicated. Should it be necessary to use any additional land for staging or for other purposes during the construction of the Work, independently arrange for the use of such lands and pay any required rental or use fees. Unless otherwise shown, specified, or agreed, all sites shall be returned to their original condition or better upon completion of the Work.

D. Nothing herein shall imply granting an exclusive use of roadways or public and/or private land employed to perform the Work.

E. Temporary Storage Buildings and Enclosures
   1. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials to be stored therein.
   2. Arrange and partition to provide security of contents and ready access for inspection and inventory.

F. Construct and use a separate storage area with adequate spill containment for hazardous materials used in constructing the Work.
   1. For the purpose of this paragraph, hazardous materials to be stored in the separate area are all products labeled with any of the following terms: Warning, Caution, Poisonous, Toxic, flammable, Corrosive, Reactive, or Explosive. In addition, whether or not so labeled, the following materials shall be stored in the separate area: diesel fuel, gasoline, new and used motor oil, hydraulic fluid, cement, paints and paint thinners, two-part epoxy coatings, sealants, asphaltic products, glues, solvents, wood preservatives, sand blast materials, and spill absorbent.
   2. Hazardous materials shall be stored in groupings according to the Material Safety Data Sheets.
   3. Develop and submit to Engineer a plan for storing and disposing of the materials above.
   4. The separate storage area shall meet the requirements of authorities having jurisdiction over the storage of hazardous materials.
   5. Hazardous materials which are delivered in containers, shall be stored in the original containers until use. Hazardous materials which are delivered in bulk, shall be stored in containers which meet the requirements of authorities having jurisdiction.
   6. Obtain and submit to Engineer a single EPA number for wastes generated at the site.
   7. The separate storage area shall be inspected by the proper authorities prior to construction of the area, upon completion of construction of the area, and upon cleanup and removal of the area.

G. In the event machinery and equipment need servicing on site, be responsible to clean environmentally hazardous materials from the site immediately.

1.6 PARKING/CONSTRUCTION TRAILER

A. Owner will utilize their nearby office for Engineer's and Owner's construction personnel office space. Contractor shall provide an adequately sized construction trailer on site for weekly meetings.

B. Provide a level pad sufficient for setting the Contractor's construction jobsite office trailer as needed (to be located by the Contractor based on the site layout). The pad shall include a gravel area for parking of minimum 7 vehicles. This work will be done within three days of mobilization at the jobsite.

C. Provide a generator or power connection to power the Contractor's jobsite trailer.

D. Employees shall park in areas as required by Contractor and approved by Engineer.

E. Traffic and parking areas shall be maintained in a sound condition, free of excavated material, construction equipment, mud, and construction materials. Repair breaks, potholes, low areas, which collect standing water, and other deficiencies.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 55 26
TRAFFIC CONTROL

PART 1 - GENERAL

1.1 GENERAL

A. This Traffic Control Specification is only required if the Contractor's work/construction activities enters or impacts the public roads right of way.

1.2 SECTION INCLUDES

A. Traffic Control Plan requirements and materials and labor necessary for implementation.

B. Traffic Control Maintainer and Flagging.

C. Work zone traffic control devices, arrow boards, and pilot cars.

1.3 RELATED SECTIONS

A. Section 01 11 00 – Summary of Work

1.4 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO) standards, latest edition:

Roadside Design Guide

B. American Traffic Safety Services Association (ATSSA) standards, latest edition:

Quality Guidelines for Temporary Traffic Control Devices & Features

C. National Cooperative Highway Research Program (NCHRP) standards, latest edition:

Report 350	Recommended Procedures for the Safety Performance Evaluation of Highway Features

D. U.S. Dept. of Transportation, Federal Highway Administration (FHWA) standards:

MUTCD	Manual of Uniform Traffic Control Devices
	Standard Highway Signs

E. Utah Department of Transportation (UDOT) standards and specifications, latest edition:

Flagger Training Handbook

Guidelines for Crash Cushions and Barrier End Treatments

Standard Section 2891 Traffic Signs

Operations Policy 06C-23 Use of Variable Message Signs (VMS)

1.5 SUBMITTALS

A. Administrative Submittals: Copies of permits, licenses, and approvals for construction as required by Laws and Regulations and governing agencies.

B. Shop Drawings:
1. Approved Traffic Control and Routing Plans: As specified herein.
2. Message Boards: Proposed locations for placement at each detour or road closure.

C. Traffic Control Supervisor(s) qualifications: Qualifications of proposed traffic control supervisor(s) and traffic control plan signatory.

1.6 TRAFFIC CONTROL SUPERVISOR

A. The traffic control supervisor shall be responsible for initiating, installing, and maintaining all traffic control devices as shown on the Traffic Control and Routing Plans, and as specified in the MUTCD and these specifications, or as directed. The traffic control supervisor shall be an employee of the Contractor and shall be assigned full time to the Project while work is underway on public roadways. The traffic control supervisor shall work exclusively with traffic control services. The designated traffic control supervisor shall also be available to be contact by the Engineer 24 hours a day for the life of this contract. The persons so designated shall have at least one year of experience directly related to work site traffic control in a supervisory capacity and shall be certified as a work site traffic control supervisor by ATSSA. Submit the name and qualifications of this person for review 7 days in advance of the date set for the preconstruction conference.

B. The traffic control supervisor shall be capable of being onsite within 45 minutes of notification. The traffic control supervisor shall make at least four inspections of all traffic controls devices each day as follows:
1. Before beginning work.
2. At mid-shift.
3. Half an hour after the end of the shift.
4. Once during the period of nonworking hours.

C. The traffic control supervisor shall make a daily record of traffic control activities using a form provided to and approved by the Engineer. Submit completed forms within 24 hours.

D. The traffic control supervisor shall oversee the security of the message boards to be implemented by the Contractor's field staff. Security measures shall be implemented daily and shall include locking the tires to the message boards, chaining the message boards to a fixed item, and other measures to prevent theft.

E. Each day the traffic control supervisor shall develop the messages for the message boards, determine the locations of the message boards, coordinate with field labor to locate the message boards, and program the message boards.

F. The traffic control supervisor shall oversee the flagging operations. For road closures, the traffic control supervisor shall prepare information handouts showing schedules and maps of the crew locations. The traffic control supervisor shall keep the handouts updated and furnish copies of the flaggers for distribution to drivers approaching closure barricades and drivers waiting to drive through single-lane zones. The traffic control supervisor shall manage the distribution of radios to flaggers, and oversee the proper functioning of radios.

G. Each evening and morning, signs shall be covered and uncovered as needed to inform the public of roadway closures, detours, work zones, and other traffic information. Each evening just before crews leave, all signs not required shall be covered and all signs required shall be uncovered. Each morning before start of construction, all signs not required shall be covered and all signs required shall be uncovered. The traffic control supervisor shall oversee the covering and uncovering of signs each evening and morning.

H. Traffic control supervisor shall oversee storage of materials and construction equipment along right-of-way, as needed to ensure compliance with the Contract Documents.

I. Traffic control supervisor shall be responsible for verifying that property owner notifications are made in accordance with Contract requirements.

1.7 FLAGGER

A. Flaggers must have a current Utah flagging certificate and must present proof of certification upon request by the Engineer.
   1. Acceptable Certifications
      a. Refer to http://www.udot.utah.gov/main/f?p=100:pg:0:::1:T,V:1385 for a list of certified instructors.

1.8 TRAFFIC CONTROL AND ROUTING PLANS

A. The Traffic Control and Routing Plans shall be prepared and/or certified as to conformance with these Specifications by a Professional Traffic Operation Engineer (PTOE) or an ATSSA certified Work Site Traffic Control Supervisor and shall include the PTOE registration number or ATSSA certification number of the certifying person.

B. Submit the initial phase Traffic Control and Routing Plans at the preconstruction conference. Submit plans for future phases of construction a minimum of 28 days before start of that construction phase to allow review and resubmittal, if necessary, and public notification. Meet with the Engineer and affected agency having jurisdiction to review each of the Traffic Control and Routing Plans for each phase of construction. Do not begin construction on any given phase before receiving written acceptance by Jordanelle Special Service District, and/or Wasatch County Traffic Division of the Traffic Control and Routing Plans for that phase.

C. Failure to submit the Traffic Control and Routing Plans within the specified time frames will not be justification for additional working days. Failure to adequately address comments in any required resubmittal also will not justify additional working days.

D. Changes to this plan shall be made only by written approval of Engineer. Secure approvals for necessary changes so as not to delay progress of the Work.

E. If multiple road closures are desired simultaneously, detours must be coordinated and approved in advance by the Engineer and the agency or agencies having jurisdiction. Allow a minimum of 14 working days for the Engineer and the agency or agencies having jurisdiction review followed by 14 working days of prior notification of residents. Multiple simultaneous road closures will require additional message boards (at each end of the closure) which shall be provided by Contractor at no additional cost for the duration of simultaneous closures.

F. Traffic Routing Plan: Show sequences of construction affecting the use of roadways, time required for each phase of the Work, provisions for decking over excavations and phasing of operations to provide necessary access, and plans for signing, barricading, and striping to provide passages for pedestrians, bicycles, and vehicles. Include schedule for covering traffic control signs (including detour signs) when not in use and uncovering just prior to use.

G. The Traffic Control Plans in the Contract Documents are guidelines only, and shall not be used in lieu of detailed Contractor-prepared plans. Detailed Traffic Control Plans shall show the location of traffic cones, barrier rail, construction zones, flaggers, stored pipe and materials, construction truck access, barricades, detours, signs, message boards, and other traffic control facilities.

H. On a time and day agreed upon between the Contractor and Engineer to describe the following week's construction operations and the traffic control provisions. At each meeting, submit a detailed update of traffic control provisions and construction crew locations. This shall be submitted in hardcopy and electronic form using a Word file. The update shall contain a list of signs and the time and location for covering and uncovering signs. The update shall include the location and wording of message control boards.

I. Any days lost due to improper traffic control will be charged against the allowable working days.

PART 2 - PRODUCTS

2.1 PERFORMANCE CRITERIA

A. Use devices and systems, which meet NCHRP-350 Report crash test requirements as defined in the four categories by the Federal Highway Administration. Some exceptions will be acceptable as stated below.

1. Category 1: Cones, tubular marker, delineators, and drums without lights must be certified by the manufacturer as meeting NCHRP-350 Report requirements.
2. Category 2: Portable sign stands with signs, Type I, II and II barricades, vertical panels, Category 1 devices with light attachments and devices not expected to cause signification vehicle velocity change. These devices and systems must be certified by FHWA as meeting NCHRP-350. Report test requirements.
3. Category 3: Portable/Temporary pre-cast concrete barrier manufactured after October 1, 2002 must be certified as meeting NCHRP-350 Report test requirements.
    a. Manufactured date to be stamped into top of each barrier section using a numeric format (ex: 10/2006) with 2 inch x 2 inch numerals, ¼ inch deep. See Standard Drawing BA 1A and BA 2.

b. Portable/Temporary pre-cast concrete barrier manufactured prior to October 1, 2002 and meeting NCHRP 230 may be used until they are no longer serviceable.

4. Category 3: Crash cushions and truck mounted attenuators must be certified by FHWA as meeting NCHRP-350 test requirements.
5. Category 4: Advanced warning arrow boards and portable variable message signs do not have to meet NCHRP-350 test requirements.

2.2 FLAGGER EQUIPMENT AND CLOTHING

A. Comply with UDOT's "Flagger Training Handbook."

B. Comply with Contract Drawings traffic control sheets.

C. Paddle:
1. Use a combination "STOP" and "SLOW" sign paddle. The paddles shall be a minimum of 18 inches wide with 6-inch series "C" letters and have a rigid fixed handle approximately 5 feet in length, from the bottom of the paddle to ground level.
2. Fabricate the combination sign paddle from sheet metal or other light semi-rigid material.
3. The background of the "STOP" face shall be red with white letters and border. The background of the "SLOW" shall be orange with black letters and border.
4. Use Type II reflective sheeting for the background, letters, and border on the faces of the STOP/SLOW paddles.

D. Clothing:
1. Flagger vest and hard hat:
a. Color: Orange, red-orange, or fluorescent version of these colors.
b. Safety vest with a minimum of 775 inches of background material. Night work requires a minimum of 20 inches of reflective material (100 inches on the front and 100 inches on the back). Reflective material will be white and/or strong yellow-green.
c. Hard hat with 10 inches of white or strong yellow-green reflective tape places around the base of the hard hat and visible to traffic from all directions.

2.3 TRAFFIC CONTROL SIGNING AND DEVICES

A. Signs:
1. Comply with this section, Article 2.1.
2. Comply with UDOT Standard Specifications, Section 02891 – Traffic Signs.
3. Comply with Contract Drawings traffic control sheets.

B. Channelizing Devices:
1. Comply with Article 2.1.
2. Comply with Contract Drawings traffic control sheets.
3. Comply with UDOT Standard Specifications, Section 02891 – Traffic Signs, for reflective sheeting.
4. Use construction orange tubular markers and cones during daylight hours only.

C. Barricades:

1. Comply with Article 2.1.
2. Comply with Contract Drawings traffic control and routing sheets.
3. Do not use rocks, asphalt, or concrete pieces, construction materials, and other debris as weighting devices for barricades. Sand bags will be permitted as long as a low center of gravity is maintained as approved.

D. Precast Concrete Barrier:
1. Comply with Article 2.1.
2. Comply with Contract Drawings traffic control and routing sheets.
3. Use an approved construction zone attenuator or permanent style end sections, as listed in UDOT Guidelines for Crash Cushions and Barrier End Treatments.
   a. Use a construction zone attenuator when approach ends of temporary precast barrier are within AASHTO clear zone.
      1) Use AASHTO Roadside Design Guide to determine proper clear zone distance requirements.
      2) Install crash cushions as per contract traffic control sheets and manufacturer's recommendations.
4. Do not use a truck mounted attenuator (TMA) to protect temporary precast barrier end for more than 24 hours. Use properly rated TMA as directed in this Section, Article 2.4, Paragraph E.

E. Impact Attenuator: Use properly rated truck mounted attenuator for the posted speed limit prior to construction.
1. NCHRP-350 Test Level 2 for speeds 45 mph or less.
2. NCHRP-350 Test Level 3 for speeds greater than 45 mph.

2.4 ADVANCE WARNING ARROW BOARD

A. Meet all standards as specified in the MUTCD, Section 6F.61 Arrow Boards.

B. Perform all functions as specified in Contract Drawings traffic control sheets and the MUTCD.

2.5 VARIABLE MESSAGE SIGNS (VMS)

A. Design, placement, operation, maintenance, and message content of portable variable message signs will conform to the current edition of the MUTCD and UDOT Operations Policy 06C-23 were applicable.

B. Portable variable message boards shall be a transportable truck or trailer mounted programmable message sign. The message sign board shall be capable of displaying three lines of message text with characters of twelve-inch minimum height formed by a bulb type, LCD, LED or electromagnetic disk matrix, and shall have a display area of 96-inches x 48-inches. At nighttime the sign display shall be self-illuminated.

C. Portable variable message boards shall be placed at least 14 calendar days before construction begins on the affected roadways and maintained by the Contractor at locations designated and provided by the Owner.

D. Provide at least two portable variable message boards throughout construction at each location impacting City streets. Additional signs may be required by Cities based upon review of Contractor's Traffic Control Plans.

PART 3 - EXECUTION

3.1 LIMITATIONS OF OPERATIONS

A. See Section 01 11 00 – Summary of Work for Contract information to coordinate construction and traffic control involving signalized intersections. Give maintaining agency a minimum of 72-hours' notice for the adjustment of signal phasing to accommodate the approved Traffic Control Plan.

B. During nonworking hours, Saturdays, Sundays, and holidays, the full width of the traveled way in both directions shall be open for use by the public.

C. Allow emergency vehicles immediate passage.

D. When construction operations are not actively in progress, one through lane of traffic in each direction shall be open to public traffic. A maximum of 15 percent vertical profile grade shall be constructed and maintained at all times in order to accommodate public traffic.

E. Minimum lane width shall be 10 feet, unless noted otherwise. Where cones are used to separate traffic lane from construction zone, do not use traffic lane for accessing construction zone, and do not store materials or equipment on or near shoulder of traffic lane side of roadway.

F. Whenever it is necessary to cross, close, or obstruct driveways and walks, whether public or private, provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of public and private travel.

G. Driveway and Private Road Closures: Maintain satisfactory means of exit for persons residing or having occasion to transact business along the route of the Work. When access to private driveways must be temporarily denied due to construction operations, notify the property owner or responsible part of such closure not less than 24 hours in advance of closure. Give notification in writing and include the estimated duration of the closure.

H. In making street crossings, do not block more than one-half the street at a time. Maintain one lane of traffic at all times. Ensure access for traffic both directions.

I. Notify the fire department, police/sheriff department, highway patrol, ambulance service, local school district, and transit 14 days before closing roadway or portion thereof. Notify said departments or agencies when streets are again passable for vehicles. Conduct operations with the least interference to fire equipment access, and at no time prevent such access. Furnish Contractor's night emergency telephone numbers to the police or sheriff's department.

J. If Work will interfere with mail delivery, move mailboxes to temporary locations accessible to postal service, and on completion of Work in each area, replace them in their original

location and in a condition equal to or better than original. When access to private driveways must be temporarily denied due to construction operations, notify the property owner or responsible part of such closure not less than 24 hours in advance of closure. Give notification in writing and include the estimated duration of the closure.

K. If Work will interfere with garbage pickup, move property owner's (resident's) garbage cans to areas accessible for garbage pickup. Garbage cans shall be returned to owner's driveway after pickup.

L. Pedestrian and cycle access along sidewalks and streets will be kept open and safe from construction activities.

M. Coordinate traffic routing with that of others working in the same or adjacent areas. Coordinate access for garbage pickup, mail delivery, and school buses.

N. Each evening prior to crew departure, sweep all Work areas to ensure all construction debris (including, but not limited to, AC waste, gravel, and dirt) has been removed from the surface of the road. Dispose of debris offsite and do not sweep into ditches or otherwise outside of Work area.

O. Barricades and Lights:
1. Provide as shown on the Traffic Control Details and in sufficient quantity to safeguard public and Work.
2. Provide as necessary to prevent unauthorized entry to construction areas and affected roads, streets, and alleyways, inside and outside of fenced area, and as required to ensure public safety and the safety of Contractor's employees, other employer's employees, and others who may be affected by the Work.
3. Provide to protect existing facilities and adjacent properties from potential damage.
4. Locate to enable access by facility operators and property owners.
5. Protect streets, roads, highways, and other public thoroughfares that are closed to traffic by effective barricades with acceptable warning signs.
6. Locate barricades at the nearest intersecting public thoroughfare on each side of the blocked section.

P. Signs and Equipment:
1. Traffic control signs and equipment shall be as described herein, the MUTCD, and the Standard Highway Signs, shown on Traffic Control Details, and as directed by Engineer.
2. Maintain existing traffic control signs during construction.
3. Variable Message Signs: Provide two variable message signs conforming to the provisions of Section 2.6 of these Specifications for use as directed by Engineer. Be responsible for moving and programming message boards as required throughout the Project.
4. Portable TOW-AWAY-NO STOPPING Signs; Place where approved by police department of the agency having jurisdiction and Owner.
5. Business Access Signs: Place at accesses to businesses in the vicinity of construction activities.

6. Traffic Cones: Provide to delineate traffic lanes to guide and separate traffic movements. Provide at obstructions such as material piles and equipment, as directed by Engineer.
7. Illuminate barricades and obstructions with warning lights from sunset to sunrise, or as directed by Engineer.
8. Use to alert general public of construction hazards, which would include surface irregularities, unramped walkways, grade changes, and trenches or excavations in roadways and in other public access areas.
9. Post-mount informational signs both sides of detour a minimum of 14 days before detouring any traffic as to the date, time, and duration of the detour. Sign shall be stenciled with 6-inch black letters on an orange background. Signs shall meet these specifications.
10. Place solar powered barricade-type lights on Road Work Ahead signs and construction speed limit signs.
11. All portable and night use signs shall use high intensity reflective sheeting.
12. Cover Detour signs when not in use and uncover just prior to use. Detour signs shall be covered with wood or metal. The use of easily displaced material such as plastic bags, burlap sacks, duct tape, etc. is not acceptable.
13. Each sign or piece of equipment shall be certified by the manufacturer to meet the requirements of these Specifications. Any sign or equipment, which is damaged, or appears to be in poor condition, must be recertified by the manufacturer. Engineer shall be the sole judge as to whether used signs or equipment supplied under this contract need recertification.

END OF SECTION

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SECTION 01 57 19
TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 - GENERAL

1.1 EXPLOSIVES AND BLASTING

A. The use of explosives on the Work will not be permitted.

1.2 DUST ABATEMENT

A. Furnish all labor, equipment, and methods required to prevent, control, and mitigate fugitive dust from the construction activities. In complying with this requirement, conform to all local requirements in all circumstances. Be responsible for damage resulting from dust generated by its activities. Dust abatement measures shall be continued until Engineer directs otherwise.

1. Unpaved Roads: Apply liquid dust palliative as appropriate for traffic areas as approved by Engineer.
2. All other Non-Paved Work Areas: Apply a liquid dust palliative (soil stabilizer type) derived from natural organic plant sources and containing no growth – or germination – inhibiting materials as approved by Engineer. Application shall be effective for dust suppression according to applicable County Health District Air Pollution Control Division dust regulations. Do not allow movement of vehicles or storage of materials on treated areas.

1.3 RUBBISH CONTROL

A. Prepare a trash abatement program and submit to Engineer for review. The program shall include placing all litter, trash, garbage, construction debris, and refuse in scavenger-proof, resealable containers. Trash includes, but is not limited to, cigarettes, cigars, gum wrappers, tissue, cans, paper, and bags. During the progress of the Work, keep the Project Site and other areas used by it in a neat and clean condition, and free from any accumulation of rubbish. Dispose of all rubbish and waste materials of any nature occurring at the Project Site, establish regular intervals of collection and disposal of such materials and waste. Keep haul roads free from dirt, rubbish, and unnecessary obstructions resulting from construction operations. Disposal of all rubbish and surplus materials shall be off the Site in accordance with local codes and ordinances governing locations and methods of disposal, and in conformance with all applicable safety laws, and to the particular requirements of Part 1926 of the OSHA Safety and Health Standards for Construction.

B. Clean up and properly dispose of any oil, fuel, and other equipment leaks at the time of occurrence. Service and maintenance vehicles shall carry a bucket and pads to absorb leaks and spills. Notify Engineer of any spills or leaks at the time of occurrence.

1.4 SANITATION

A. Toilet Facilities: Provide fixed or portable chemical toilets wherever needed for the use of employees. Toilets at construction job sites shall conform to the requirements of Part 1926 of the OSHA Standards for Construction.

B. Sanitary and Other Organic Wastes: Establish a regular collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities or organic material wastes from any other source related to the construction operations shall be disposed of away from the Site in a manner satisfactory to Engineer and in accordance with all laws and regulations pertaining thereto.

1.5 CHEMICALS

A. All chemicals used during project construction or furnished for project operation, whether soil sterilant, pesticide, disinfectant, polymer, reactant or of other classification, shall show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture. Use of all such chemicals and disposal of residues shall be in strict accordance with the printed instructions of the manufacturer.

1.6 CULTURAL RESOURCES

A. Direct attention to the National Historic Preservation Act of 1966 (16 U.S.C. 470) and 36 CFR 800 and NRS 383.121 which provide for the preservation of potential historical architectural, archaeological, or cultural resources (hereinafter called "cultural resources").

B. Conform to the applicable requirements of the National Historic Preservation Act of 1966 and NRS 383.121 as they relate to the preservation of cultural resources.

C. In the event potential cultural resources are discovered during subsurface excavations at the Site of construction, institute the following procedures:
   1. Engineer will issue a Field Order directing the cessation all construction operations at the location of such potential cultural resources find. Mark the area in an appropriate manner to ensure that all construction equipment, activities, and personnel remain clear of the area until further notice.
   2. Field Order shall be effective until such time as a qualified archaeologist can be called to assess the value of these potential cultural resources and make recommendations to the State Historic Preservation Office.

D. If the archaeologist determines that the potential find is a bona fide cultural resource, at the direction of the State Historic Preservation Office, suspend work at the location of the find under the provisions for changes contained in Articles 10, 11, and 12 of the General Conditions.

1.7 AIR QUALITY

A. Maintain all vehicles and equipment in proper tune.

B. Use Best Available Control Technology on construction equipment, including a timing retardation.

C. Use natural-gas powered construction equipment where possible.

D. Encourage employee car-pooling.

1.8 NOISE

A. Comply with the hours of work as allowed by the local jurisdiction or land management agency.

B. Noise limits on construction equipment will comply with the noise limits of the local jurisdiction or land management agency. All construction equipment shall be equipped with manufacturer's standard noise control devices (i.e., mufflers, acoustical lagging, and/or engineer enclosures). Take special care not to throttle the engine excessively and keep engine speed as low as possible. Do not leave the equipment running or idling needlessly, especially when near noise-sensitive land uses. Noise-sensitive land uses include, but are not limited to, residences, schools, hospitals, libraries, retirement and elderly care centers, religious and worship facilities, courts of law, certain noise-sensitive professional offices, and quiet recreational areas such as campgrounds and hiking trails.

C. Use newer equipment whenever possible. Inspect all construction equipment at periodic intervals to ensure proper maintenance and the presence of noise control devices (i.e., mufflers and shrouding, etc.)

D. Keep heavy, noisier equipment a minimum of 100 feet away from the property line of any noise-sensitive land use for any length of time. Avoid coming closer than 200 feet if multiple pieces of equipment are operating simultaneously. If such cases are unavoidable, avoid throttling the engine excessively or leaving the equipment running needlessly. Heavy equipment shall be operated in a manner to comply with the jurisdiction's noise ordinance and vibration performance standard. In order to comply with these requirements, it may be necessary to operate heavy equipment only 30 minutes out of each one-hour period at distances closer than 200 feet from an occupied property. During the remaining 30 minutes, the equipment should move further away or be shut down, but may resume 30 minutes later.

E. Locate stationary noisy equipment away from construction boundaries that are near noise-sensitive uses.

F. Concrete trucks shall perform initial mixing and other activities that require high revving of the truck engine a minimum of 600 feet from noise-sensitive land uses. Keep engine revolutions per minute as low as possible at closer distances.

G. Whenever possible, use electric hand tools rather than gas-powered tools.

H. If operation of dewatering pumps and generators is required between the hours of 6 p.m. and 7 a.m. and within 600 feet of a noise-sensitive land use, they shall be treated with acoustical noise control measures (e.g., mufflers, shrouding, and/or enclosures) so as not to exceed 56 dba at 50 feet or other appropriate requirements of the local jurisdiction.

I. If requested by the Engineer, install temporary noise barriers for construction activities, including staging areas that occur closer than 100 feet from noise-sensitive land uses. Noise barriers can be made of plywood, heavy vinyl curtain material, natural or temporary earth berms, or stockpiles of construction material.

1.9 CONTROL OF SURFACE WATER

A. Be advised that portions of the Work site could be subject to flooding from surface waters. The site is located slightly lower than the existing highway and could be subject to flooding in heavy rain events.

B. Be responsible for protecting the Work and temporary facilities from damage due to flooding, runoff, surface water flows, and related subsurface flows until final Project closeout. Provide protection for all aspects of the Work whether temporary or permanent. Provide all materials and equipment required to protect the Work. No additional payment will be made by Owner for providing protective measures or for any damage resulting from said flows. All damage from said flows shall be completely replaced in accordance with the Contract Documents at no additional cost to Owner.

1.10 PROTECTION OF WETLANDS

A. The Contractor shall not disturb areas outside the construction area as many of the low lying areas surrounding the project site could be classified as wetlands. Areas to the west of Old Highway 40 are listed federal wetlands and under no circumstance are to be disturbed.

END OF SECTION

SECTION 01 58 13
TEMPORARY PROJECT SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Provide two project identification signs, complete, in accordance with the Contract Documents.

PART 2 - PRODUCTS

2.1 SIGN CONSTRUCTION

A. Construct each sign of 3/4-inch painted, exterior grade plywood with 4-inch by 4-inch supports and 2-inch by 4-inch cross bracing capable of withstanding 15 psf wind loads.

B. Each sign face shall be 4-feet vertical by 8-feet horizontal.

C. Design sign for professional appearance.

2.2 COLORS

A. Face: White.

B. Lettering: Black, block letter style.

2.3 SIGN CONTENT

A. The content and appearance of the project sign shall be as directed by Owner. Content shall include Project Title, Owner, Contractor, Engineer, and scheduled completion date.

B. Submit a drawing to illustrate proposed sign content to Engineer for approval prior to construction.

PART 3 - EXECUTION

3.1 SIGN LOCATION

A. Locate sign on the Project Site as directed by Engineer.

B. The sign shall be set four feet above the ground, measured from grade to the lower edge of the plywood sheet.

C. If the sign will be located outside of an Owner-acquired right-of-way or easement, secure written permission from the owner of the property where the sign will be located and submit to Engineer.

3.2 REMOVAL

A. Remove the project sign upon Substantial Completion of the Work.

END OF SECTION

SECTION 01 71 00
MOBILIZATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Organization and mobilization of the forces.

B. Transporting construction plant and equipment to the jobsite and setting up of same.

C. Transporting various tools, materials, and equipment to the jobsite.

D. Erection of temporary buildings and facilities as required for field offices, staging, storage, and construction operations.

1.2 RELATED SECTIONS

A. Section 01 20 00 – Measurement and Payment

B. Section 01 31 30 – Safety and Security Program

1.3 PAYMENT FOR MOBILIZATION

A. Payment for mobilization shall be as described in Section 01 20 00 – Measurement and Payment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Mobilization shall include the following principal items:
1. Provide all required insurance certificates and bonds.
2. Move onto the site, or portion of site as available, of all plant and equipment required for first month's operations including office and storage trailers.
3. Install temporary construction power, wiring, and lighting facilities.
4. Develop construction water supply.
5. Provide all on-site communication facilities, including telephones, cordless phone antenna, and radio pagers.
6. Provide on-site sanitary facilities and potable water facilities.
7. Arrange for and erection of work and storage yard.
8. Construct and implement security features and requirements complying with Section 01 31 30 – Safety and Security Program.
9. Obtain all required permits.
10. Post all OSHA required notices and establish safety programs.

11. Provide Superintendent at the job site full time.

3.2 SUBMITTAL REQUIREMENTS

A. The following submittals are due by the day indicated and must be approved by Owner as a condition precedent to completion of mobilization.

No.	Submittal	Specification Section
1.	Quality Assurance / Control Plan	01 45 00
2.	Mobilization Plan	01 71 00
3.	Safety Program	01 31 30
4.	Concrete Mix Designs	03 30 00
5.	List of Permits and Licenses	01 41 26
6.	Schedule of Submittals	01 33 20

3.3 MOBILIZATION PLAN

A. Within 15 Days after receipt of the Notice to Proceed, submit a mobilization plan to Engineer for approval, which shall include a breakdown showing the estimated value of each component of mobilization as described in paragraphs 3.1 and 3.2 herein.

B. Include a bar chart schedule showing each item of mobilization listed in paragraphs 3.1 and 3.2 herein and include scheduled start date, finish dates, and total duration. The plan shall also list each activity to be initiated in the first 90 Days following Notice to Proceed, complete, with scheduled start date, finish date, and total duration.

END OF SECTION

SECTION 01 71 30
SITE CONDITIONS SURVEYS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements to document conditions of the Project Site and adjacent properties before construction begins and after completion of the Work. Methods include still photographs, digital video recordings, and topographic surveys.

1.2 RELATED SECTIONS

A. Section 31 10 00 – Site Preparation

B. Section 31 23 00 - Earthwork

1.3 SUBMITTALS

A. Submit all photographs, digital videos, and topographic survey data of the preconstruction conditions to Engineer for record purposes prior to, but not more than three weeks before, commencement of any construction activities.

1.4 CLOSEOUT SUBMITTALS

A. Complete and submit all digital videos, still photographs, mapping, and survey data of the postconstruction conditions to Engineer prior to final inspection by Owner and Engineer.

B. Provide postconstruction survey data to Engineer as follows:
   1. Submit topographic mapping for each site hereinbefore identified for topographic mapping and surveys as a separate electronic map (drawing) in AutoCAD Release 2020, or later.
   2. Also submit each AutoCAD site map in hard copy plot format (six copies).
   3. Engineer will review hardcopy plots for accuracy relative to the specified requirements.
   4. Amend mapping files, as required, based on review of the hardcopy plots by Engineer.
   5. The electronic mapping files shall be produced using field survey techniques with sufficient accuracy for reproduction and use as base maps at a scale of 1"=20' horizontal and 2-foot contour intervals as specified for National Map Accuracy Standards.
   6. All electronic mapping files shall be three-dimensional.
   7. Submit lists of survey points for all topographic surveys in ASCII text file format.
   8. Provide mapping and points files on one or more compact discs in a format acceptable to Engineer.

C. Submit six copies of the disk media.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Conduct thorough preconstruction and postconstruction Site conditions surveys of the entire Project. Site conditions surveys shall consist of photographs, digital video recordings, and topographic mapping. Sufficient photographs, supplemented by digital video, shall be provided and submitted to Engineer to resolve any damage claims, which may arise due to the construction of this Project. Develop topographic mapping using the Project coordinates, and referenced to the Project base lines and bench marks. Mapping shall be adequate to ascertain preconstruction and postconstruction conditions (including elevations) of all public and private property within and adjacent to the construction limits.

B. Digital video or photographic surveys shall include, but not be limited to, all access roads used to transport material or equipment to and from the Site and elevation of roadways, drives, walks, and buildings. Use spot elevation surveys to document the elevation on abutting roadways, drives, and walks, taken at approximately 20-foot intervals and at the point of juncture with any structure to which they are attached or otherwise influenced by the Work. In addition, take elevations of all building slabs along the Project route. Provide topographic mapping as specified herein.

C. Digital video recordings required as part of this Section and by Section 31 10 00 – Site Preparation and Restoration and Section 31 23 00 - Earthwork may be combined into a single set of media provided the requirements for videos specified in both Sections are met.

D. As a minimum, note preconstruction and postconstruction conditions and perform digital video surveys of the following:
   1. Areas used to access the Site or haul materials and equipment to the Site.
   2. The access road, both original and relocated locations and ultimately to the Site.
   3. All Work areas, including, but not limited to, access corridors, disposal areas, and staging areas.
   4. Any work completed by other contractors at the Site that will be impacted or otherwise affected by Work of this Project.

E. Supplement digital video surveys with still photographs and spot elevation surveys as required to document the original condition and location of existing features and facilities.

F. Provide digital video records in DVD-R format.

G. Topographic mapping shall be conducted to document the post-construction topography of the following Sites.
   1. All graded/disturbed portions of the WTP site with sludge basins

END OF SECTION

SECTION 01 71 50
PROTECTION AND RESTORATION OF EXISTING FACILITIES

1.1 GENERAL

A. Protect all existing utilities and improvements not designated for removal and restore damaged or temporarily relocated utilities and improvements to a condition equal to or better than they were prior to such damage or temporary relocation, in accordance with the Contract Documents.

B. Call Bluestakes before commencing any digging for location of underground utility lines and cable locations. The number is (800) 662-4111.

C. Provide temporary 6-foot chain link fencing panels for protection of all open excavations and trenches within public streets, residential areas, and all other locations with the exception of unimproved open areas where excavations and/or pipeline trenches that can be safely sloped in accordance with current OSHA standards to provide safe access without the use of shoring devices. Temporary fencing panels shall fully enclose open excavations and trenches, and shall remain in place during all non-working hours.

D. Provide temporary caps over all large diameter pipe during non-working hours to prevent unauthorized access.

1.2 RELATED SECTIONS (NONE)

1.3 RIGHTS-OF-WAY

A. Do not perform any work that would affect any oil, gas, sewer, or water pipeline; any telephone, telegraph, or electric transmission line; any fence; or any other structure. Do not enter upon the rights-of-way involved until notified by Engineer that Owner has secured authority therefore from the proper party.

B. After authority has been obtained, give said party due notice of intention to begin work, if required by said party, and remove, shore, support or otherwise protect such pipeline, transmission line, ditch, fence, or structure or replace the same.

C. When two or more contracts are being executed at one time on the same or adjacent land in such manner that work on one contract may interfere with that on another, the Owner will determine the sequence and order of the Work. When the territory of one contract is the necessary or convenient means of access for the execution of another contract, such privilege of access or any other reasonable privilege may be granted by Owner to the Contractor so desiring, to the extent, amount, in the manner, and at the times permitted and in full conformance with the conditions of the Contract Documents.

D. No such decision as to the method or time of conducting the Work or the use of territory shall be made the basis of any claim for delay or damage, except as provided for temporary suspension of the Work in the General Conditions of the Contract.

1.4 PROTECTION OF STREET OR ROADWAY MARKERS

A. Do not destroy, remove, or otherwise disturb any existing survey markers or other existing street or roadway markers without proper authorization. Do not begin pavement breaking or excavation until all survey or other permanent marker points that will be disturbed by the construction operations have been properly referenced. Accurately replace survey markers or points disturbed after all street or roadway resurfacing has been completed.

1.5 RESTORATION OF PAVEMENT

A. General: Replace all paved areas cut or damaged during construction with similar materials of equal thickness to match the existing adjacent undisturbed areas, except where specific resurfacing requirements have been called for in the Contract Documents or in the requirements of the agency issuing a permit. The pavement restoration requirement to match existing sections shall apply to all components of existing sections, including sub-base, base and pavement. Temporary and permanent pavement shall conform to the requirements of the affected jurisdictional agency. Neatly saw cut pavements, which are subject to partial removal, in straight lines. Refer to project drawings for specific pavement restoration requirements.

B. Temporary Resurfacing: Wherever required by the public authorities having jurisdiction place temporary surfacing promptly after backfilling and maintain such surfacing for the period of time fixed by said authorities before proceeding with the final restoration of improvements.

C. Permanent Resurfacing: In order to obtain a satisfactory junction with adjacent surfaces, saw cut back and trim the edge so as to provide a clean, sound, vertical joint before permanent replacement of an excavated or damaged portion of pavement. Damaged edges of pavement along excavations and elsewhere shall be trimmed back by saw cutting in straight lines. All pavement restoration and other facilities restoration shall be constructed to finish grades compatible with adjacent undisturbed pavement. Refer to plans for minimum dimension of T-patch replacement width over disturbed pipeline trenches in paved areas.

D. Pavement Crown: In areas where pipeline trenching impacts an existing crown of asphalt, survey, and submit to Engineer documentation showing the pre-construction location of the crown prior to trenching. Replace the crown of asphalt to its pre-construction location to the satisfaction of the governing agency and Engineer.

1.6 EXISTING UTILITIES AND IMPROVEMENTS

A. General. Protect underground utilities and other improvements, which may be impaired during construction operations, regardless of whether or not the utilities are indicated on the Drawings. Take all possible precautions for the protection of unforeseen utility lines to provide for uninterrupted service and to provide such special protection as may be necessary.

B. Except for utilities specifically located on the Drawings, be responsible for exploratory excavations (potholing) as deemed necessary to determine the exact locations and depths of utilities, which may interfere with Work. Perform all such exploratory excavations as soon as practicable after Notice to Proceed and, in any event, a sufficient time in advance of construction to avoid possible delays to the Work's progress. When such exploratory

excavations show the utility locations as shown on the Drawings to be in error, so notify Engineer. Refer to plans for minimum advance distance that potholing must be performed prior to pipeline trenching work.

C. The number of exploratory excavations required shall be that number which is sufficient to determine the alignment and grade of the utility.

D. Utilities to be Moved: In case it becomes necessary to move the property of any public utility or franchise holder, such utility company or franchise holder will, upon request of the Contractor, be notified by Owner to move such property within a specified reasonable time. When utility lines that are to be removed are encountered within the area of operations, notify Engineer a sufficient time in advance for the necessary measures to be taken to prevent interruption of service.

E. Utilities to be Removed: Where the proper completion of the Work requires temporary or permanent removal and/or relocation of an existing utility or other improvement which is indicated, remove and, without unnecessary delay, temporarily replace or relocate such utility or improvement in a manner satisfactory to Engineer and the owner of the facility. In all cases of such temporary removal or relocation, restoration to the former location shall be accomplished in a manner that will restore or replace the utility or improvement as nearly as possible to its former locations and to as good or better condition as found prior to removal.

F. Owner's Right of Access: Owner and owners of public utilities and franchises reserve right to enter at any time upon any public street, alley, right-of-way, or easement for the purpose of making changes in their property made necessary by the Work of this Contract.

G. Underground Utilities Indicated: Existing utility lines that are indicated or the locations of which are made known prior to excavation and that are to be retained, and all utility lines that are constructed during excavation operations shall be protected from damage during excavation and backfilling and, if damaged, shall be immediately repaired or replaced unless otherwise repaired by the owner of the damaged utility. If the owner of the damaged facility performs its own repairs, reimburse said owner for the costs of repair.

H. Underground Utilities Not Indicated: In the event of damage to existing utility lines that are not indicated or the locations of which are not made known prior to excavation, make a verbal report of such damage immediately to Engineer and a written report thereof promptly thereafter. Notify the utility owner of the damage. If directed by Engineer, repairs shall be made under the provisions for changes and extra work contained in the General Conditions.

I. Damages. Costs of locating and/or repairing damage not due to failure to exercise reasonable care, and removing or relocating such utility facilities not indicated in the Contract Documents with reasonable accuracy, and for equipment on the project which was actually working on that portion of the Work which was interrupted or idled by removal or relocation of such utility facilities, and which was necessarily idled during such Work will be paid for as extra Work in accordance with the provisions of the General Conditions.

J. Approval of Repairs: All repairs to a damaged utility or improvement are subject to inspection and approval by an authorized representative of the utility or improvement owner before being concealed by backfill or other work.

K. Fire Hydrants: Keep all fire hydrants and water control valves free from obstruction and available for use at all times.

L. Maintaining in Service: Unless indicated otherwise, all oil and gasoline pipelines, power, and telephone or the communication cable ducts, gas and water mains, irrigation lines, sewer lines, storm drain lines, poles, and overhead power and communication wires and cables encountered along the line of the Work shall remain continuously in service during all the operations under the Contract, unless other arrangements satisfactory to the Engineer are made with the owner of said pipelines, duct, main, irrigation line, sewer, storm drain, pole, or wire or cable. Be responsible for and repair all damage due to construction operations. The provisions of this Section shall not be abated even in the event such damage occurs after backfilling or is not discovered until after completion of the backfilling.

M. Utility Service Laterals: Utility service laterals are not shown on the plans. Anticipate that there are no less service laterals than there are homes where project trenches are located in the vicinity of a street between a home and the utility main. Protect in place, or remove and replace to the satisfaction of the utility owner, all utility service laterals encountered during construction. Duration of utility service outages and public notification procedures shall conform to the standards of the controlling agency and these Contract documents.

1.7 TREES OR SHRUBS WITHIN STREET RIGHTS-OF-WAY AND PROJECT LIMITS

A. General: Except where trees or shrubs are indicated to be removed, exercise all necessary precautions so as not to damage or destroy any trees or shrubs, including those lying within street rights-of-way and project limits. Do not trim or remove any trees unless such trees have been approved for trimming or removal by the jurisdictional agency or Owner. Trim or replace existing trees and shrubs which are damaged during construction using the services of a certified tree company under permit from the jurisdictional agency and/or the Owner.

B. Trimming; symmetry of the tree shall be preserved; no stubs or splits or torn branches left; clean cuts shall be made close to the trunk or large branch. Do not use spikes for climbing live trees. Cuts over 1-1/2 inches in diameter shall be coated with a tree paint product that is waterproof, adhesive, and elastic, and free from kerosenes, coal tar, creosote, or other material injurious to the life of the tree.

C. Replacement: Immediately notify the jurisdictional agency and/or Owner if any tree or shrub is damaged by construction operations. If, in the opinion of said agency or Owner, the damage is such that replacement is necessary, replace the tree or shrub at no additional expense to Owner. The tree or shrub shall be of a like size and variety as the one damaged, or, if of a small size, the pay to the owner of said tree a compensatory payment acceptable to the tree or shrub owner, subject to the approval of the jurisdictional agency or Owner. The size of the tree or shrub shall not be less than 1-inch diameter nor less than 6 feet in height. Planting of replacement trees and shrubs shall be in accordance with the recommendations of the nursery furnishing the plants. Unless otherwise indicated, water and maintain the replacement trees and shrubs for 6 months after planting.

1.8 LAWN AREAS (NOT USED)

1.9 UNIMPROVED AREAS

A. Remove and stockpile topsoil prior to construction in accordance with Division 01 specifications. Replace topsoil prior to restoration of unimproved areas.

B. Unimproved areas, including unclassified open spaces, fields, and unimproved rights-of-way, damaged during construction shall be repaired to match pre-construction conditions to the satisfaction of the land owner and Owner. At a minimum, unimproved areas shall be smoothed and finished graded with topsoil to match preconstruction topography, and reseeded using a native seed mix acceptable to the land owner and Owner.

C. All slopes greater than 2H : 1V shall be protected with erosion control matting prior to reseeding.

1.10 OTHER SURFACE IMPROVEMENTS

A. Conduct a pre-construction survey of all properties that will be impacted by construction operations. All improvements that have the potential to be impacted by construction, including but not limited to fencing, landscaping, boulders, retaining walls, irrigation systems, and other public and/or private improvements, shall be protected in place, or if necessary, removed and replaced with like kind or better quality following construction.

B. Work that will impact residential properties shall be subject to the notification and coordination requirements of Section 01 71 40 – Public Information Program.

1.11 NOTIFICATION BY CONTRACTOR

A. Prior to any excavation in the vicinity of any existing underground facilities, including all water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications, or television cables; all traffic signal and street lighting facilities; and all roadway and state highway rights-of-way, notify the owners or agencies responsible for such facilities not less than three days nor more than seven days prior to excavation so that a representative of said owner or agencies can be present during such Work if they so desire.

B. When it is necessary to temporarily deny access to property, or when any utility service connection must be interrupted, give notices sufficiently in advance to enable the affected persons to provide for their needs. Notices shall conform to any applicable local ordinance and, whether delivered orally or in writing, shall include appropriate information concerning the interruption and instructions on how to limit inconvenience caused thereby.

C. Contact, cooperate with, and provide written notice (including Contractor's phone number) at least seven days prior to beginning Work on each street. The written notice shall include the approximate schedule and explanation of Work and shall be given to each homeowner, business, all emergency agencies, schools, and residents, which will be affected by the project; particularly in reference to temporary interruptions to vehicular access. At least twenty-four hours prior to initiation of Work, provide a second notice to confirm the scope of scheduled Work. Submit a copy of the notifications to Engineer, for approval, prior to the start of construction. Make verbal door-to-door communication prior to construction to remind all

affected parties of the construction to take place. In addition, be responsible to answer and resolve any conflicts that may arise between a homeowner or business owner and the construction personnel.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 74 19
DISPOSAL OF WATER

PART 1 - GENERAL

1.1 SUMMARY

A. Prepare a detailed listing of all discharges and overflows that will occur during the disinfection procedure.

1.2 REFERENCES

A. American Water Works Association (AWWA) standards, latest edition.

AWWA C651	Disinfection Water Mains
AWWA C652	Disinfection of Water Storage Facilities

1.3 SUBMITTALS

A. Submit a listing of every significant discharge from a drain valve, pump well, overflow, drain piping, and from all related appurtenances. "Significant discharge" is defined as a volume that is greater than that required to exercise or fill piping with chlorinated water and briefly flush. The listing shall be utilized as input for the Construction Progress Schedule to identify the volume and duration for every discharge that must be accounted for. Very minor discharges for air-release piping or drains that are exercised briefly to ensure disinfection do not need to be identified on the Construction Progress Schedule for dechlorination or discharge.

B. Include the proposed method and equipment for dechlorination, including type of agent; temporary feed pumps, and appurtenant feed equipment.

C. Final Report: Submit to Engineer a final report of each significant discharge, its locations, dates sampled for effectiveness of dechlorination, and the test results.

PART 2 - PRODUCTS

2.1 MATERIALS FOR DECHLORINATION

A. Where dechlorination of water released back to the environment is required, use a sodium bisulfate or equivalent dechlorinator. Sodium bisulfite, if used, shall be applied at a ratio of at least 1.47 parts per every part of chlorine to be removed. This is to remove all of the free active chlorine. Since the reaction produces a byproduct of hydrochloric acid, it will also tend to lower the pH of the water and remove calcium carbonate from the water. If the pH drops below 6.0, add calcium carbonate back into the water during the dechlorination process to restore the pH to an acceptable level of at least 6.0.

B. The process of dechlorination consists of utilizing a chemical metering pump to inject a 44 percent (or less) solution of sodium bisulfite into a temporary discharge pipe with a static mixer and after a few seconds (plus or minus three) withdrawing sample for a chlorine residual analyzer. Based on the results, the analyzer shall send a signal to adjust the chemical feed rate.

PART 3 - EXECUTION

3.1 MAJOR DISCHARGES, PUMP WELLS, OVERFLOWS

A. General: List each drain valve, pump well, and overflow, along with proposed volume and duration of discharge during the disinfection procedure. Locations requiring dechlorination shall be indicated. Refer to Drawings to obtain detailed information on size, location, and layout of facilities and access conditions. Review the site of each proposed discharge for the conditions at the proposed discharge.

END OF SECTION

SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Contract closeout, including final cleaning, preparation, and submittal of closeout documents, warranties and bonds, and final completion certification.

B. Closeout submittals and submittal forms in both hard copy and electronic format.

1.2 RELATED SECTIONS

A. Section 01 45 00 – Quality Control.

B. Section 01 78 39 – Project Record Documents

1.3 SUBMITTALS

A. Closeout Documents: Submit the following closeout documents prior to making a written request for Final Completion.
   1. Project record drawings and documents per Section 01 78 39 – Project Record Documents.
   2. Shop drawings.
   3. Keys and keying schedule.
   4. Post construction survey record documents, where required.
   5. Quality Control reports per Section 01 45 00 – Quality Control.
   6. Final Operation and Maintenance Manuals.
   7. Maintenance stock items; spare parts and special tools.
   8. Written warranties and bonds where required.
   9. Bonds for roofing or maintenance, if indicated.
   10. Access Badges and Parking Permits.
   11. Release of liens or release of claims forms submitted by all subcontractors and suppliers, if requested by Owner

B. Evidence of Compliance With Inspections and Other Requirements of Governing Authorities: Submit the following:
   1. Special Inspection Reports.
   2. Certificate of Occupancy, if applicable.
   3. Release from each affected property owner or agency indicating final acceptance.

C. Operation and Maintenance Manuals
   1. One percent of the contract price will be withheld from any monies due as progress payments, if at the 75 percent construction completion point, the approved *Operations and Maintenance Manual* complying with Section 01 33 20- Contractor Submittals has not been submitted. The aforementioned amount will be withheld by Owner as the agreed, estimated value of the approved *Operations and Maintenance Manuals.* Any such retention of money for failure to submit the approved *Operations*

and Maintenance Manuals on or before the 75 percent construction completion point shall be in addition to the retention of any payments due under General Conditions of the Contract.

D. Final Change Order: A final Change Order shall be submitted and processed if required. Final payment and close-out procedures shall comply with requirements of the Contract Documents.

1.4 CLOSEOUT TIMETABLE

A. Establish dates for equipment testing, acceptance periods, and on-site instructional periods as required under the Contract Documents. Such dates shall be established not less than one week prior to beginning any of the required activities, to allow Owner, Engineer, and their authorized representatives sufficient time to schedule attendance at such activities.

1.5 COMPLETION PROCEDURES

A. When Contractor believes Substantial Completion has been achieved, request in writing to Engineer that Substantial Completion be recognized as having been achieved and request that Owner issue a Certificate of Substantial Completion. Prior to making such request, the following must be complete:
   1. Work necessary for the safe, proper, and complete use or operation of the facility as intended.
   2. Punch list of items remaining to be completed, for submission with the request for issuance of a Certificate of Substantial Completion.
   3. Submit and receive acceptance of accurate record drawings for all work completed to date.
   4. Submit and receive acceptance of all specified warranties, bonds, guarantees and operation and *Operations and Maintenance Manuals*.
   5. Complete all required vendor training, testing, and where required, start-up.
   6. Deliver all required spare parts, maintenance stock items, and special tools.
   7. Complete equipment and communications system testing successfully.

B. Upon receipt of the request, Engineer and designated representatives will review the request, the Work, and the above requirements to determine whether Substantial Completion has been achieved. If this review fails to support Substantial Completion, Engineer will notify Contractor in writing citing the reasons for rejection. If Engineer determines that Substantial Completion has been achieved, the following procedures will be followed:
   1. Engineer, his/her representative, and user representatives will review the Work and the punch list to assure all deficiencies are noted on a final punch list.
   2. Engineer will schedule and conduct a pre-final walk-through of the facility with representatives of Owner, Engineer, Contractor, and others, for the purpose of formally reviewing the Work, the final punch list, and the readiness of the Work for use. A copy of the final punch list will be furnished to all participants and any additional items noted during the walk-through will be added to the list.
   3. Upon completion of the pre-final walk-through, Engineer will prepare a request to Owner establishing the date for Substantial Completion as date of the walk-through, provided the walk-through has verified that the Work is in fact ready for use and

occupancy by Owner for its intended purpose. Upon approval of this request by Owner, the facility will be considered Substantially Complete.

C. Final Completion will be deemed to have occurred when Work is completed including the following:
   1. All final punch list items have been corrected, signed off by Contractor and Engineer, and demonstrated to Owner during a final walk-through.
   2. All updates to record drawings, and *Operations and Maintenance Manuals* have been made.
   3. Demobilization and site cleanup are complete.
   4. Facilities and/or equipment have been properly demonstrated to be functioning as required.
   5. Owner has received releases from all parties who are entitled to claims against the subject project, property, or improvement pursuant to the provisions of law.
   6. New permanent cylinders and key blanks for all locks have been provided to Owner.

D. Certificate of Final Completion
   1. When all items have been completed or corrected, submit written documentation to Engineer that the entire Work is complete in accordance with the Contract Documents and request final inspection.
   2. Upon completion of final inspection by Owner and Engineer, Owner will either prepare a Certificate of Final Completion of the entire Work or advise all parties of Work not satisfactorily complete. If necessary, repair or replacement and inspection procedures will be repeated until Owner accepts the Work and issues a Certificate of Final Completion.

E. Partial Utilization may be desired at Owner's option, as described in the General Conditions. If Partial Utilization is requested, the same procedure for completion of that portion of the Work as indicated in paragraphs A and B above, will be used.

1.6 CLOSE-OUT PROCEDURE

A. Engineer and Contractor shall meet and resolve all outstanding issues including, but not limited to:
   1. Claims and adjustments for time or costs
   2. Outstanding, unused allowances
   3. Procedures for handling warranty issues.

B. A Final Change Order shall be processed if required. Final payment and close out procedures shall comply with all requirements of the Contract Documents.

1.7 MAINTENANCE AND GUARANTEE

A. Comply with the maintenance and guarantee requirements contained in General Conditions of the Contract.

B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as a part of such required repair work, and any repair or resurfacing which becomes necessary by reason of such settlement shall likewise be considered as a part of such required repair work unless Contractor has obtained a statement in writing from the

affected private authority or public agency releasing Owner from further responsibility in connection with such repair or resurfacing. Submit such release(s) to Engineer.

C. Make all repairs and replacements promptly upon receipt of written order from the Owner. If the Contractor fails to make such repairs or replacements promptly, the Owner reserves the right to do the Work and the Contractor and his surety shall be liable to the Owner for the cost thereof.

1.8 BOND

A. Furnish a Performance Bond as required by General Conditions of the Contract.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. Certificate of Final Completion of the Work by Owner will be withheld until requirements for final cleanup of the Project Site are complete as follows:
1. Perform final cleaning prior to inspections for final acceptance.
2. Employ skilled workers who are experienced in cleaning operations.
3. Use cleaning materials that are recommended by manufacturers of surfaces to be cleaned.
4. Avoid scratching, discoloring, and otherwise damaging surfaces being cleaned.
5. Clean roofs.
6. Broom clean and power wash exterior paved surfaces and rake clean other surfaces of sitework. Police yards and grounds to keep clean.
7. Remove dust, cobwebs, and traces of insects and dirt.
8. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, fixtures, and Equipment.
9. Remove nonpermanent protection and labels.
10. Polish finish hardware.
11. Wash and shine mirrors.
12. Polish glossy surfaces to clear shine.
13. Clean ducts, blowers, and coils when units were operated without filters during construction.
14. Clean light fixtures and replace burned-out or dim lamps.

3.2 WASTE DISPOSAL

A. Remove temporary structures and facilities and arrange for and dispose of surplus materials, waste products, and debris as follows:
1. Prior to making disposal on private property, obtain written permission from owner of such private property.
2. Do not fill ditches, washes, or drainage ways which may create drainage problems.
3. Do not create unsightly or unsanitary nuisances during disposal operations.

4. Maintain disposal site in safe condition and good appearance.
5. Complete leveling and clean-up prior to final acceptance of the Work.

3.3 TOUCH-UP AND REPAIR

A. Touch up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for final acceptance.

B. Refinish or replace entire surfaces that cannot be touched-up or repaired satisfactorily.

3.4 DEMOBILIZATION

A. Demobilization shall include moving plant and equipment, field trailers, construction materials, debris, and so forth from the Site as well as performing final cleanup.
1. Disturbed areas shall be restored to their original state or better.
2. Permanent improvements damaged during construction operations shall be repaired or replaced at no additional cost to Owner.
3. Remove all equipment, materials, waste, and debris from the site and restore site to original condition upon completion of construction.
4. The work area shall be restored to its original or better condition and shall be inspected and approved by Engineer.

END OF SECTION

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SECTION 01 78 39
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Maintain at the Site for Owner, one record copy of the Drawings, Specifications, Operation and Maintenance manuals, coordination drawings, and Shop Drawings that are clearly marked with a red pen to indicate all changes and or revisions resulting from, but not limited to, the following:
   1. Actual Project as constructed.
   2. Addenda.
   3. Change Orders and other modifications.
   4. Engineer's instructions.
   5. Field revisions.
   6. Requests for Information (RFI).
   7. All other changes.

B. Give special attention to recording the horizontal and vertical location of all buried utilities that differ from the locations indicated, or which were not indicated on the Contract Drawings.

C. Record drawings shall be supplemented by any detailed sketches as necessary or directed to fully indicate the Work, as actually constructed.

D. Section Includes:
   1. Maintenance of Documents and Samples
   2. Marking Devices.
   3. Recording.
   4. Close-out Submittal Delivery.

1.2 RELATED SECTIONS

A. 01 77 00 - Project Closeout

1.3 MAINTENANCE OF DOCUMENTS AND SAMPLES

B. Store documents and samples in field office apart from documents used for construction.

C. Provide files and racks for storage of documents.

D. Provide locked cabinet or secure storage space for storage of samples.

E. Maintain documents in clean, dry, legible condition and in good order. Keep record documents separate from those used for construction.

F. Make documents and samples available at all times for reference by Engineer and Owner.

G. In the case of those drawings which depict the detail requirement for equipment to be assembled and wired in the factory, such as motor control centers and the like, the record drawings shall be updated by indicating those portions which are superseded by change order drawings or final shop drawings, and by including appropriate reference information describing the change orders by number and the shop drawings by manufacturer, drawing, and revision numbers.

H. During progress meetings, record documents may be reviewed to ascertain that changes have been recorded.

I. Updated Drawings, when provided by Engineer, will be substituted for the hand markups provided Contractor prints the applicable Drawings and inserts them into the record set each month.

J. Copies of the record drawings will be audited regularly by Engineer after the month in which the Notice to Proceed is given as well as on completion of the Work. Failure to properly maintain record drawings in an up-to-date condition may result in the withholding of payments due at the sole discretion of Owner.

1.4 MARKING DEVICES

A. Use a red color pen for recording all information to all documents defined herein.

1.5 RECORDING

A. Label each document "CONFORMING TO CONSTRUCTION RECORD" in neat large red printed letters.

B. Record information concurrently with construction progress, at the time the material or equipment is installed. Do not conceal any work until required information is recorded.

C. Drawings shall be legibly marked to record actual construction per the following:
   1. Record actual depths of various elements of foundations in relation to finish first floor datum.
   2. Record actual as-built depths, horizontal and vertical location, (at every direction change and a maximum of 100 feet intervals on straight runs), of underground pipes, duct banks, and other buried utilities. Reference horizontal location to Project coordinate system and vertical elevations to Project datum.
   3. Identify and record specific details of pipe connections, location of existing buried features and utilities located during excavation, and the final locations of piping, equipment electrical conduits, manholes, and pull boxes (horizontal coordinates and vertical elevation).
   4. Identify and record location of spare conduits including beginning, ending, and routing through pull boxes, and manholes. Record spare conductors, including number and size, within spare conduits, and filled conduits.
   5. Record actual schedules, lists, layout drawings, and wiring diagrams.
   6. Record field changes of dimension and detail.
   7. Record changes made by instruction from Engineer or by Change Order.
   8. Record details not on original Contract Drawings.

D. Specifications and Addenda shall be legibly marked to record:
   1. Manufacturer, trade name, catalog number, and supplier for each product and item of equipment actually installed.
   2. Changes made by instruction from Engineer or by Change Order.

E. Record potholing data and installation of marker balls.

F. All surveying for record documents shall be performed by a licensed surveyor.

1.6 CLOSEOUT SUBMITTALS

A. At Contract closeout, deliver complete record documents to Engineer as required in Section 01 77 00 - Project Closeout. Final payment will not be acted upon until the record drawings have been prepared and delivered to Engineer.

B. The information submitted will be incorporated by Engineer into final drawings to be provided to Owner. Be responsible for the accuracy of submitted construction information. Engineer will assume that the information provided by Contractor is correct and faithfully represents actual construction.

C. This submittal shall include the record paper set along with 2 CDs. Each CD shall contain .pdf files and .dwg files of each drawing.

D. Prepare submittal with transmittal letter containing:
   1. Date.
   2. Project title and number.
   3. Contractor's name and address.
   4. Title and number of each record as-built document.
   5. Signature of Contractor's authorized representative and a statement that certifies that the record documents are accurate and reflect what was actually installed during construction.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 81 10
SEISMIC DESIGN CRITERIA

PART 1 - GENERAL

1.1 SUMMARY

A. This section Includes seismic design criteria for the following:
   1. Anchorage of mechanical and electrical equipment and piping.
   2. Seismic design of tanks and anchorage of tanks.
   3. Other structures or items as specified or indicated on the Drawings.

1.2 REFERENCES

A. International Code Council (ICC) documents as follows:

IBC	International Building Code, 2018 Edition with Utah state amendments

B. American Society of Civil Engineers (ASCE) documents as follows:

ASCE 7	Minimum Design Loads for Buildings and Other Structures, 2016 Edition

1.3 SUBMITTALS

A. Shop Drawings and Calculations: Submit shop drawings and structural calculations in accordance with Section 01 33 20 - Submittal Procedures. All drawings and calculations shall be signed and sealed by a licensed Civil or Structural engineer as required below under "Qualifications."

B. ICC-ES reports for concrete anchors.

1.4 QUALITY ASSURANCE

A. Qualifications
   1. Licensed Professionals: Design of items required by this Section and other items not specifically shown in the Contract Documents shall be performed by a Civil or Structural Engineer licensed to practice in the state of Utah.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Design Criteria: Design in accordance with the requirements of the International Building Code and ASCE 7.
   1. Seismic acceleration variables to be used in design are as follows:
      a. Risk Category: IV

b. The design 5 percent damped spectral response acceleration at short periods, S_{DS} = 0.498g.
c. The design 5 percent damped spectral response acceleration at a period of 1 second, S_{D1} = 0.287g.
d. Soil Site Class = D.
e. Seismic Design Category = D.

2. Seismic Importance Factor for Anchorage of Mechanical and Electrical Equipment: 1.50.
3. Seismic Importance Factor for the Design of Tanks and the Anchorage of Tanks: 1.50.
4. Do not use friction to resist sliding due to seismic forces.
5. Use only headed anchor bolts, adhesive anchors, or welded studs for anchors resisting seismic forces. Embedded anchor bolts used to resist seismic forces shall have a standard hex bolt head.
   a. Adhesive anchors must have current ICC-ES reports showing that the anchors meet IBC requirements when installed in cracked substrates.
   b. Do not use other types of anchors unless indicated on the Drawings or approved in writing by Engineer.
   c. Seismic forces must be resisted by direct bearing on the fasteners used to resist seismic forces. Do not use connections which use friction to resist seismic forces.

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 01 81 11
WIND DESIGN CRITERIA

PART 1 - GENERAL

1.1 SUMMARY

A. This section Includes design criteria for the following when exposed to wind forces:
   1. Anchorage of mechanical and electrical equipment and piping.
   2. Design of tanks and anchorage of tanks.
   3. Other structures or items as specified or indicated on the Drawings.

1.2 REFERENCES

A. International Code Council (ICC) documents as follows:

IBC	International Building Code, 2018 Edition with Utah state amendments

B. American Society of Civil Engineers (ASCE) documents as follows:

ASCE 7	Minimum Design Loads for Buildings and Other Structures, 2016 Edition

1.3 SUBMITTALS

A. Shop Drawings and Calculations: Submit shop drawings and structural calculations in accordance with Section 01 33 20 - Submittal Procedures. All drawings and calculations shall be signed and sealed by a licensed Civil or Structural engineer as required below under "Qualifications."

B. ICC-ES reports for concrete anchors.

1.4 QUALITY ASSURANCE

A. Qualifications
   1. Licensed Professionals: Design of items not specifically shown in the Contract Documents shall be performed by a professional Civil or Structural Engineer licensed to practice in the state of Utah.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Design Criteria: Design in accordance with the requirements of the International Building Code and ASCE 7.
   1. Basic Wind Speed : 115 miles per hour
   2. Risk Category: IV

3. Exposure: C
4. Topographic Factor: 1.0
5. Use only headed anchor bolts, adhesive anchors, or welded studs for anchors resisting wind forces. Embedded anchor bolts used to resist seismic forces shall have a standard hex bolt head.
    a. Adhesive anchors must have current ICC-ES reports showing that the anchors meet IBC requirements.
    b. Do not use other types of anchors unless indicated on the Drawings or approved in writing by the Engineer.
    c. Wind forces must be resisted by direct bearing on the fasteners used to resist wind forces.

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 01 91 14
EQUIPMENT TESTING AND STARTUP

PART 1 - GENERAL

1.1 SUMMARY

A. Equipment testing and startup are required for satisfactory completion of the Contract and, therefore, shall be completed within the Contract Time.

B. Section Includes:
1. Startup Plan.
2. Certificates of Installation and Startup Services.
3. Record Keeping.
4. Factory Performance Testing.
5. Special Tools and Lubricating equipment.
6. Installation Services.
7. Phase I - Startup.
8. Phase II - Operational Performance Test.
9. Phase III - Post Operational Performance Test.
10. Lubrication.
11. Instructional Services.

1.2 DEFINITIONS

A. Owner Purchased Water Treatment Plant Equipment (Package System): The treatment package equipment purchased by the Owner to be installed by the Contractor. The Start Up Scope of Services of the treatment package equipment is provided in these contract documents.

B. Phase I - Startup is defined as that time period when Contractor and manufacturer's field representatives perform check starts and functional testing of individual equipment items, subsystems, and then the entire systems.

C. Phase II - Operational Performance Test is a 14-Day period when Owner operates the entire system as the design intended in automatic mode and Contractor corrects problems and difficulties.

D. Phase III - Post Operational Performance Test is a 90-Day period during which Owner operates the entire process, followed by a final inspection of each equipment item, subsystem, and then the entire system by Contractor and manufacturers' representatives.

E. Instructional Services is training by qualified representative(s) of the manufacturer during each of the 3 phases defined above.

F. Factory Performance Testing is testing for equipment performance at the point of manufacture or assembly.

1.3 SUBMITTALS

A. Submit startup plan a minimum of 90 days prior to beginning startup procedures.
   1. Submit and have an approved detailed and coordinated startup plan for each piece of equipment, subsystem, and the entire system.
   2. The Plan and Progress Schedule shall include the following activities:
      a. Manufacturer's services and startup dates.
      b. Submittal dates for certificates of installation and startup services.
      c. Operator training dates for each phase.
      d. Submittal of operation and Maintenance manuals.
      e. Functional test dates.
      f. Operational performance test dates.
      g. Post operational performance test dates.
   3. The plan shall include test logs for each item of equipment and each system. Include testing of alarms, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.
   4. Provide summary of shutdown requirements for existing systems which are necessary to complete startup of new equipment and systems.
   5. Revise and update startup plan based upon review comments, actual progress, and to accommodate changes in the sequence of activities.
   6. System startup plan shall be coordinated with Owner's operations staff and Engineer to ensure operational intent is achieved.

B. Startup Records:
   1. Maintain and submit the following records generated during each phase of startup defined above in article titled Definitions:
      a. Daily logs of equipment testing identifying all tests conducted and outcome.
      b. Logs of time spent by manufacturer's representatives performing services on the Site.
      c. Equipment lubrication records.
      d. Electrical phase, voltage, and amperage measurements.
      e. Insulation resistance measurements.
      f. Data sheets of control loop testing, including testing and calibration of instrumentation devices and setpoints.
      g. Detailed, point-by-point, sensor/controlled device/field device to PLC to HMI screen witnessed validation checklist for all telemetry and SCADA tags utilizing a fully functional network or other telemetry system available at the Owner's plant or other Owner-designated facility.

C. Certificates of Installation and Startup Services
   1. At completion of installation and functional testing, furnish Certificate of Installation and Startup Services, signed by manufacturer, Contractor, and Owner's authorized representatives. Each form shall be completed for individual pieces of equipment in a timely manner as construction proceeds.
   2. Submit 3 original copies of each completed form to Engineer.
   3. Certify that:
      a. Equipment has been properly installed, adjusted, aligned, and lubricated.
      b. Equipment is free of any stresses imposed by connecting piping or anchor bolts.

c. Equipment is suitable for satisfactory full-time operation under full load conditions.
d. Equipment operates within the allowable limits for vibration.
e. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.
f. Control logic for startup, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly functioning.
g. For remotely monitored and controlled devices, functionality shall not be certified until indication and controls are tested using local and remote SCADA based indications.

4. Furnish a specific written report prepared and signed by the electrical and/or instrumentation subcontractor certifying:
   a. Motor control logic that resides in motor control centers, control panels, and circuit boards furnished by the electrical and/or instrumentation Subcontractor has been calibrated and tested and is properly operating.
   b. Control logic for equipment startup, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly operating.
5. Sign and submit for acceptance the forms and field manufacturer reports along with the manufacturer's representative prior to proceeding with Phase II testing.

D. Submit electronic media recordings of training sessions.

PART 2 - PRODUCTS

2.1 FACTORY PERFORMANCE TESTING

A. Test equipment for proper performance at the point of manufacture or assembly.

B. Demonstrate equipment meets specified performance requirements.

C. Submit certified copies of factory test results to Engineer for review and approval.

D. Do not ship equipment until certified copies of factory test reports have been approved by Engineer. Written acceptance of factory test results does not constitute final acceptance.

2.2 SPECIAL TOOLS AND LUBRICATING EQUIPMENT

A. Furnish, according to manufacturer's recommendations, special tools required for checking, testing, parts replacement, and maintenance. Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics, including valve keys and stems.

B. Time of Delivery: Submit special tools and lubricating equipment to Engineer when unit is placed into operation and after operating personnel have been properly instructed in operation, repair, and maintenance of equipment.

C. Quality: Provide tools and lubricating equipment of a quality comparable to what the equipment manufacturer uses.

PART 3 - EXECUTION

3.1 INSTALLATION SERVICES

A. Provide competent and experienced technical representatives of manufacturers of all equipment and systems as necessary to assemble or install the equipment.

B. Contractor to coordinate with the Owner Purchased water treatment plant equipment provider on their proposed start-up services according to their scope of work. The Contractor will need to develop a start-up plan in conjunction with the water treatment equipment provider to ensure that there are no gaps in the start up plan execution.

C. After equipment is installed, have representatives perform initial equipment and system adjustment and calibration.

D. Documentation: Provide Engineer with original approved copies of the following prior to the Operational Performance Test (Phase II):
   1. Certificate of equipment Installation Services and Certificate of Startup Services by manufacturers' representatives for each piece of equipment installed in the Work, verifying:
      a. That the equipment is installed in accordance with manufacturers' recommendation and in compliance with the Contract Documents.
      b. That equipment is tested and is functioning as intended.
      c. That nothing in the installation voids any warranty.
      d. That the equipment, as installed, is ready to be operated by others.
      e. That the equipment will reliably perform the function for which it is intended.
   2. A detailed report by manufacturers' representatives, for review by Engineer of the installation services performed, including:
      a. Description of calibration and adjustments made.
      b. Description of any parts replaced and reasons for replacing.
      c. Type, brand name, and quantity of lubrication used, if any.
      d. Description of problems encountered and corrective action taken.
      e. Any special instructions left with Contractor or Engineer.

E. Functional Testing and Startup:
   1. Functionally test mechanical and electrical equipment for proper operation after general startup and testing tasks have been completed.
   2. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration.
   3. Perform initial checks in the presence of Engineer and with the assistance of the manufacturer's representative.
   4. Demonstrate proper operation of each instrument loop function including alarms, local and remote controls, instrumentation, and other equipment functions.

5. Generate signals with test equipment in each control mode. For remotely monitored and controlled devices, functionality shall not be certified until indication and controls are tested using local and remote SCADA based controls and indications.
6. Conduct continuous 8-hour test under full load conditions. Replace parts that operate improperly.

F. Provide fuel and other consumables for duration of test.

G. Work shall not proceed to Phase II Operational Testing until Engineer has reviewed and approved all certificates and reports.

3.2 PHASE I – STARTUP

A. During this phase, make certain that the Work is ready for the Operational Performance Test by demonstrating that the system operates as a complete system.

B. Provide all fuel, power, chemicals, and all other incidentals required for Phase I testing and start up activities at no additional cost to Owner.

C. The startup of equipment may impact the operation of Owner's existing system(s).
1. Submit a detailed written Startup Plan as noted above.
2. Contractor shall reconfirm startup with Engineer 2 weeks prior to startup.

D. Startup Demonstration:
1. Provide a startup and operation demonstration of each component of the system and of the complete systems in manual and automatic mode of operation.
2. Demonstrate restart of equipment and systems in the manual and automatic mode of operation (when applicable) following a simulated power outage.
3. Invite Owner's representatives to attend the startup demonstration and provide with an approved agenda of activities/services to be performed at least 90 Days prior to the startup date.
4. Submit certificates of installation and startup services signed by Contractor and equipment manufacturer's representatives, verifying that this service has been performed to all the parties' satisfaction. Use the forms provided at the end of this Section.

E. For mechanical systems:
1. Remove rust preventatives and oils applied to protect equipment during construction.
2. Flush lubrication systems and dispose of flushing oils. Recharge lubrication system with lubricant recommended by manufacturer.
3. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.
4. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.
5. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.
6. Perform cold alignment and hot alignment to manufacturer's tolerances.
7. Inspect hand and motorized valves for proper adjustment.

a. Tighten packing glands to ensure no leakage, but permit valve stems to rotate without galling.
b. Verify valve seats are positioned for proper flow direction.

8. Tighten leaking flanges or replace flange gasket. Inspect screwed joints for leakage.
9. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.

F. For electrical systems:
1. Perform insulation resistance tests on wiring except 120 volt lighting and wiring and control wiring inside electrical panels.
2. Perform continuity tests on grounding systems.
3. Test and set switchgear and circuit breaker relays for proper operation.
4. Perform direct current high potential tests on all cables that will operate at more than 2,000 volts. Obtain services of independent testing lab to perform tests.
5. Check motors for actual full load amperage draw. Compare to nameplate values.

G. For instrumentation systems:
1. Bench or field calibrate instruments and make required adjustments and control point settings.
2. Leak test sampling tubing and piping.
3. Energize transmitting and control signal systems, verify proper operation, ranges, and settings.

H. Documentation:
1. All components shall be certified prior to starting the Operational Performance Test.
2. No Work shall be deemed Substantially Complete until the 14 Day operational test has been successfully performed.
3. Phases I and II of the classroom training must be completed prior to Engineer issuing substantial completion.

3.3 PHASE II – OPERATIONAL PERFORMANCE TEST

A. After certification forms have been submitted and accepted, all preliminary operation and maintenance manuals are complete, all submittals are complete, request in writing to Engineer to start Phase II.

B. After Engineer approves in writing, Owner will operate the entire system for a minimum of 14 uninterrupted consecutive and continuous Days before it is to be placed into permanent service.

C. If there are any interruptions during this phase, Owner will immediately stop the test and notify Contractor of the problem or deficiency.

D. After the deficiency has been corrected, repeat the startup and functional testing on the defective equipment and resubmit the certificates and field reports, and the 14 Day Operational Performance Test shall start over from the beginning.
1. Each time the test is interrupted, the test will start over at the beginning, until 14 Days of uninterrupted operation has been achieved.

2. Owner will not accept the system until the 14 Day test has been completed as described above.
3. Actual product shall be utilized during this phase of the test.
4. Before this phase of the test can start, all safety and Work items shall be substantially completed and capable of automatic operation as intended.

E. Operational Performance Test (Phase II) shall not begin until all Phase I - Startup testing has been completed, certificate forms have been submitted and approved, and written approval to start has been given by Engineer.
1. Conduct all tests in the presence of Engineer.
2. Provide fuel, power, chemicals, and other incidentals for all testing at no additional cost to Owner.
3. Coordinate with Owner's Operations staff to allow for actual product developments prior to the 14-Day test and allow sufficient time in the schedule for this activity.

3.4 PHASE III – POST OPERATIONAL PERFORMANCE TEST

A. During this phase, Owner will operate the entire system for at least 90 Days.
1. At the end of 90 Days, make a complete system check to determine if the entire system is operating satisfactorily.
2. Perform a final inspection of all equipment, systems, and subsystems to ensure that all equipment and systems are operating in conformance with the intent of the design and the manufacturer's recommendations.

B. Submit a Certificate of 90 Day Post-Operational Performance Test Services after the 90-Day test has been completed satisfactorily. Contractor and manufacturer's representative shall each sign each applicable certificate to document that all equipment, systems, and subsystems are operating in accordance with the design and the manufacturer's recommendations.

C. Engineer may request, in writing, additional training by the manufacturer's representative to be scheduled during final inspection of equipment.

3.5 LUBRICATION

A. Where lubrication is required for proper operation of equipment, incorporate the necessary provisions in accordance with the manufacturer's requirements. Where possible, make lubrication automated and positive.

B. Upon completion of the 90-Day Post Operational Performance, a qualified manufacturer's representative shall perform preventive maintenance, such as change break-in lubrication, complying with manufacturer's recommendations.

C. Oil Reservoirs: Where oil is used, provide a reservoir of sufficient capacity to lubricate the unit for a 7-day period.

3.6 INSTRUCTIONAL SERVICES

A. Provide competent and experienced technical manufacturer's representative to give detailed instructions to Owner's personnel for operation and maintenance of equipment.

1. Provide individual training sessions for all 3 phases described in this Section.
2. Training shall be a combination of classroom and hands-on training as required for each phase.

B. Recordings of Training Sessions:
1. Provide audio video recording of each training session on electronic media and submit 3 copies to Engineer within 14 Days of each actual training session.
2. Where multiple groups of equipment are presented simultaneously, the media shall include a clearly understandable table of contents/chapter index.

C. Satisfactorily complete functional testing before beginning operator training.
1. Coordinate all training sessions with Engineer and manufacturers' representatives.
2. Coordinate to prevent overlapping sessions.
3. Arrange sessions so that individual operators and maintenance technicians do not attend more than 2 sessions per week.
4. Notify Engineer and Owner at least 90 Days before classroom training sessions are to begin so Owner can schedule training times with operating personnel.
5. Reconfirm classroom training dates with Engineer 2 weeks prior to actual training.
6. Ensure that a sign in sheet is completed for each training session, and that the sign in form and certificate are submitted to Engineer after each phase of training is completed.

D. Provide equal service time for similar types of equipment differing in model, size, or manufacturer.

E. Utilize approved preliminary *Operation and Maintenance Manual* for specific pieces of equipment or systems for that piece of equipment or system.

F. Submit the original Certificate of Instructional Services, signed by Contractor and equipment representative for each phase of training and verifying that classroom training has been accomplished to satisfaction of all parties, for review and approval prior to proceeding with Phase II.

G. Training provided by manufacturer's representative does not constitute Substantial Completion.

H. Use of equipment for training shall not void manufacturer or Contract warranties.

END OF SECTION

DIVISION 03
CONCRETE

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SECTION 03 11 00
CONCRETE FORMING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish, fabricate, and install concrete formwork, bracing, shoring, supports, and falsework in accordance with Contract Documents.

B. Work shall include installation of form ties, clips, supports and other appurtenances necessary to meet Specifications and produce finished concrete structures.

1.1 RELATED SECTIONS

A. Section 03 30 00 – Cast-In-Place Concrete

1.2 REFERENCES

A. American Concrete Institute (ACI) standards, most recent editions:

ACI 317	Standard Tolerances for Concrete Construction and Materials
ACI 318	Building Code Requirements for Reinforced Concrete
ACI 347	Formwork for Concrete

B. National Sanitation Foundation (NSF), most recent edition:

NSF 61	Drinking Water System Components, Health Effects

C. U.S. Department of Commerce, National Institute of Standards and Technology, (NIST) standards, latest editions:

PS 1	Structural Plywood
PS 20	American Softwood Lumber Standard (ASLS)

1.3 SYSTEM DESCRIPTION

A. Be responsible for the design, engineering, construction, maintenance, and safety of all falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, and the requirements specified herein.

B. Design and construct falsework to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time.

C. Falsework Calculations and Drawings: All falsework or vertical shoring installations where the height of the falsework or vertical shoring, as measured from the top of the sills to the soffit of the superstructure, exceeds 14 feet, or where individual horizontal span lengths exceed 16 feet, or provision for vehicular or railroad traffic through falsework or vertical shoring is made, shall be approved and signed by a civil or structural engineer, registered in the State of Utah. Always maintain a current copy of the falsework plan or shoring layout on the job site.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop Drawings: Submit detailed drawings of the falsework proposed to be used. Such drawings shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, means of protecting existing construction which supports falsework, and typical soil conditions. Submittals shall include the following:
   1. Form ties and all related accessories, including taper tie plugs, if taper ties are used.
   2. Form gaskets.
   3. Form releasing agent, including NSF certification when applicable.
   4. List of form materials and locations for use.

PART 2 - PRODUCTS

2.1 GENERAL

A. Except as otherwise expressly accepted by Engineer, all lumber brought on the job site for use as forms, shoring, or bracing shall be new material. All forms shall be smooth surface forms and shall be of the following materials:
   1. Walls: Steel or plywood panel.
   2. Columns: Steel, plywood or fiberglass.
   3. Roof and Floor: Plywood.
   4. All Other Work: Steel panels, plywood or tongue and groove lumber

B. Form materials which may remain or leave residues on or in the concrete that is in contact with potable water shall be classified as acceptable for potable water under NSF 61 within 30 days of application or use.

2.2 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Form ties (general):
      a. Burke Penta-Tie, Burke Company.
      b. Richmond Snap-Tys, Richmond Screw Anchor Company.
      c. Gates Ties, Gates and Sons, Inc.
      d. Engineer approved equal.
   2. Form ties (water retaining structures):

a. Burke Taper-Tie, Burke Company.
b. Taper-Ty, Richmond Screw Anchor Company.
c. Engineer approved equal.

2.3 FORM AND FALSEWORK MATERIALS

A. Materials for concrete forms, formwork, and falsework shall conform to the following requirements:
1. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with U.S. Product Standard PS 20.
2. Plywood for concrete formwork shall be new, waterproof, synthetic resin-bonded, exterior type Douglas Fir or Southern Yellow Pine plywood manufactured especially for concrete formwork and shall conform to the requirements of PS 1 for Concrete Forms, Class I, and shall be edge sealed.
3. Form materials shall be metal, wood, plywood, or other approved material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade shown. Metal forms shall be an approved type that will accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.

B. Unless otherwise indicated, provide exterior corners in concrete members with 3/4-inch chamfers. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

C. Forms and falsework to support the roof and floor slabs shall be designed for the total dead load, plus a live load of 50 psf (minimum). The minimum design load for combined dead and live loads shall be 100 psf.

2.4 FORM TIES

A. Provide form ties with integral waterstops with a plastic cone on both sides of walls, or other suitable means for forming a conical hole to ensure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 1-1/2 inches; and all such fasteners shall be such as to leave holes of regular shape for reaming.

B. Form ties for water-retaining structures shall have an integral waterstop that tightly fits the form so that it cannot be moved from the midpoint of the tie. Removable taper ties may be used when approved by Engineer. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie.

2.5 FABRICATION

A. Tolerances: The variation from established grade or lines shall not exceed 1/4-inch in 10 feet and there shall be no offsets or visible waviness in the finished surface. All other tolerances shall be within the tolerances of ACI 117.

PART 3 - EXECUTION

3.1 GENERAL

A. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. Assume full responsibility for the adequate design of all forms, and any forms which are unsafe or inadequate in any respect shall promptly be removed from the Work and replaced at no increased cost to Owner. Provide worker protection from protruding reinforcement bars in accordance with applicable safety codes. Provide sufficient number of forms of each kind to permit the required rate of progress to be maintained. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state and Federal regulations.

B. Install plumb and string lines before concrete placement and maintain during placement. Such lines shall be used by both Contractor and Engineer and shall be in sufficient number and properly installed. During concrete placement, continually monitor plumb and string line form positions and immediately correct deficiencies.

C. Concrete forms shall conform to the shape, lines, and dimensions of members as called for on the Drawings, and shall be substantial, free from surface defects, and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

3.2 FORM CONSTRUCTION

A. Construct forms in conformance with ACI 347.

B. All forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Provide suitable and effective means on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Plywood, 5/8-inch and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete. The forms shall be tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1 to 1-1/2-inch diameter polyethylene rod held in position to the underside of the wall form. Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable to the Engineer. Whenever concrete cannot be placed from the top of a wall form in a manner that meets the requirements of the Contract Documents, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of Section 03 30 00 - Cast-in-Place Concrete. The size, number, and location of such form windows shall be as acceptable to Engineer.

C. Vertical Surfaces: All vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is shown. Not less than 1 inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Such permission will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

D. Construction Joints: Concrete construction joints will not be permitted at locations other than those shown or specified, except as may be acceptable to Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory affect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.

E. Form Ties

1. Embedded Ties: Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar as specified for finish of concrete surfaces in Section 03 30 00 - Cast-in-Place Concrete. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Do not remove ties in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, provide rubber grommets where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 2 inches back from the formed face or faces of the concrete.
2. Removable Ties: Where taper ties are approved for use, the larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, thoroughly clean the hole and roughen for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. Fill the hole completely with nonshrink grout for water bearing and below-grade walls. The hole shall be completely filled with nonshrink or regular cement grout for above-grade walls which are dry on both sides. Exposed faces of walls shall have the outer 2 inches of the exposed face filled with a cement grout which shall match the color and texture of the surrounding wall surface.

3.3 REMOVAL OF FORMS

A. Careful procedures for the removal of forms shall be strictly followed, and this Work shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted. In the case of roof slabs and above-ground floor slabs, forms shall remain in place until test cylinders for the roof concrete attain a minimum compressive strength of 90 percent of the 28-day strength specified in Section 03 30 00 - Cast-in-Place Concrete; provided, that no forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or unit has attained 90 percent of the specified 28-day strength and has been in place for a minimum of 14 days. The time required to establish

said strength shall be as determined by Engineer who will make several test cylinders for this purpose from concrete used in the first group of roof panels placed. If the time so determined is more than the 14-day minimum, then that time shall be used as the minimum length of time. Forms for all vertical walls and columns shall remain in place at least 2 days after the concrete has been placed. Forms for all parts of the Work not specifically mentioned herein shall remain in place for periods of time as determined by Engineer and ACI 347.

If the contractor needs to remove the formwork for suspended slabs prior to the 90 percent of the specified 28-day strength or the minimum of 14 days, the contractor shall reshore the slab immediately upon removing formwork until the slab has reach the 90 percent of the specified 28-day strength and has been in place for a minimum of 14 days.

3.4 REUSE OF FORMS

A. Forms may be reused only if in good condition and only if acceptable to Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on all exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to Engineer.

3.5 MAINTENANCE OF FORMS

A. Forms shall be maintained at all times in good condition, particularly as to size, shape, strength, rigidity, tightness, and smoothness of surface. Forms, when in place, shall conform to the established alignment and grades. Before concrete is placed, the forms shall be thoroughly cleaned. The form surfaces shall be treated with a non-staining mineral oil or other lubricant acceptable to the Engineer. Any excess lubricant shall be satisfactorily removed before placing the concrete. Where field oiling of forms is required, the Contractor shall perform the oiling at least 2 weeks in advance of their use. Exercise care to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

3.6 FALSEWORK

A. Place falsework shall be placed on a solid footing, safe against undermining, and protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall not exceed 20 tons. When falsework is supported on any portion of the structure which is already constructed, the load imposed by the falsework shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

END OF SECTION

SECTION 03 20 00
CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish, fabricate and install reinforcing steel as shown on Contract Documents.

B. Work includes installation of tie wires, clips, supports, and other appurtenances necessary to meet Specifications and produce finished concrete structures.

1.2 RELATED SECTIONS

A. Section 03 30 00 – Cast-In-Place Concrete

1.3 REFERENCES

A. American Concrete Institute (ACI) standards, most recent editions:

ACI 315	Details of Concrete Reinforcement
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures

B. American Welding Society (AWS):

D1.4	Structural Welding Code – Reinforcing Steel

C. ASTM International (ASTM) standards, most recent editions:

ASTM A615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A706	Standard Specification for Low Alloy Steel Deformed Bars for Concrete Reinforcement
ASTM A775	Standard Specification for Epoxy-Coated Reinforcing Steel Bars
ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

D. Concrete Reinforcing Steel Institute (CRSI) standards, most recent editions:

Manual of Standard Practice

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Submit details of the concrete reinforcement steel and concrete inserts at the earliest possible date after receipt of the Notice to Proceed.

C. Include, but not limit to, the following:
   1. Complete bar schedule, bar details and erection drawings to conform to ACI 315.
   2. Each type of bar marked with identification corresponding to identification tag on bar.
   3. Length, type, and location of all splices.
   4. Erection drawings shall be clear, easily legible and to a minimum scale of:
      a. 1/4 inch = 1 foot.
      b. 1/8 inch = 1 foot if bars in each face are shown in separate views.
   5. Size and location of openings.

D. Furnish a certified Affidavit of Compliance issued by steel manufacturer that reinforcing steel furnished for project meets requirements of ASTM standards referenced herein, as applicable.

E. Do not use Contract Documents as erection drawings.

1.5 QUALITY ASSURANCE

A. Qualifications
   1. Welding operators, processes, and procedures to be qualified in accordance with AWS D1.4.
   2. Welding operators to have been qualified during the previous 12 months prior to commencement of welding.

B. Certifications
   1. Submit manufacturer's certification that products submitted meet requirements of standards referenced.

1.6 DELIVERY, STORAGE AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Store reinforcing steel on wood supports in a manner that prevents it from coming in contact with the ground.

C. Store only bars with same identifying label in same stack.

D. Cover epoxy coated reinforcement for protection against both moisture and ultraviolet light and so that condensation does not form on the bars.

E. When handling coated bars, use systems with padded contact areas.

F. Thoroughly inspect coated steel after delivery to the job site and again after installation to ensure that it is not damaged.
   1. Repair damage with patching material meeting manufacturer's requirements.
   2. Promptly patch sheared ends and other cuts or exposed areas before detrimental oxidation occurs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Mechanical Couplers:
      a. Lenton Form Saver by nVent.
      b. Dowel Bar Splicer System by Dayton Superior Corporation.
      c. BarSplice Products by FC Industries.
      d. Engineer-approved equal.

2.2 REINFORCEMENT STEEL

A. Materials:
   1. Reinforcing bars: ASTM A615, Grade 60.
   2. Reinforcing bars to be welded: ASTM A706.
   3. Smooth dowels: ASTM A615, Grade 60 plain billet steel bars epoxy coated in accordance with ASTM A775. Provide slip dowel sleeves to allow longitudinal movement equal to joint width plus 1/4 inch.
   4. Slip Dowel Sleeve: One or two component Speed Dowel System as manufactured by Greenstreak, inc, to accept 3/4-inch diameter x 12-inch long slip dowels, including epoxy coating when specified herein or shown on Drawings.
   5. Welded wire fabric: ASTM A1064 and the details indicated; provided, that welded wire fabric with longitudinal wire of W4 size wire and smaller shall be either provided in flat sheets or in rolls with a core diameter of not less than 10 inches; and provided further, that welded wire fabric with longitudinal wires larger than W4 size shall be provided in flat sheets only.
   6. Spiral reinforcement: Cold drawn steel wire conforming to the requirements of ASTM A1064.
   7. Welding Electrodes: E90 meeting requirements of AWS D1.4.

B. Fabrication of Bars:
   1. Fabricate with cold bends conforming to recommended dimensions shown in ACI 318.
   2. Field fabrication will be allowed only if Contractor has equipment to properly fabricate steel to same tolerances as for shop fabrications.
   3. Attach identification tags with identifying mark.
   4. Contractor may at his option continue steel reinforcement through openings in walls and slabs, then field cut opening.

2.3 BOLSTERS, CHAIRS AND ACCESSORIES

A. Conform to ACI 315 and CRSI Manual of Standard Practice.

B. Provide spacers, bolsters, chairs, ties and other devices necessary to properly space, place, support, and fasten steel reinforcement in place during concrete placement.

C. Metal accessories shall be stainless steel with plastic coated tips where legs will be exposed in finished concrete surfaces. Color of plastic shall be grey to match concrete color.

D. Do not use rocks, broken bricks, wood blocks, or concrete fragments for support of steel reinforcement.

E. Support between Reinforcing Steel and Formed Exposed Surfaces: Metal bar chairs.

2.4 PRECAST CONCRETE BLOCK BAR SUPPORTS (DOBIES)

A. Supports between Reinforcing Steel for Roof Slabs: Concrete block prohibited.

B. Minimum Compressive Strength of Blocks: 5,000 psi in seven days.

C. Minimum Bearing Area: 9 square inches. Place as required to maintain specified clearances.

D. Wire ties shall be embedded in concrete block bar supports.

2.5 MECHANICAL COUPLERS

A. Provide mechanical couplers where shown and where approved by Engineer. The couplers shall develop a tensile strength, which exceeds 125 percent of the yield strength of the reinforcement bars being spliced at each splice.

B. Where the type of coupler used is composed of more than one component, supply all components required for a complete splice. This shall apply to all mechanical splices, including those splices intended for future connections.

C. Reinforcement steel and coupler used shall be compatible for obtaining the required strength of the connection. Straight threaded type couplers shall require the use of the next larger size reinforcing bar or shall be used with reinforcing bars with specially forged ends which provide upset threads which do not decrease the basic cross section of the bar.

2.6 EPOXY GROUT

A. Epoxy for grouting reinforcing bars shall be specifically formulated for such application, for the moisture condition, application temperature, and orientation of the hole to be filled. Epoxy grout shall meet the requirements found in Section 03315 - Grout.

2.7 FABRICATION

A. Tolerances:

1. Sheared lengths: plus or minus 1 inch.
2. Overall dimensions of stirrups, ties, and spirals: plus or minus ½ inch.
3. All other bends: +0 inch, -½ inch.

B. Minimum diameter of bends measured on the inside of the rebar to be as indicated in ACI 318.

C. Ship all reinforcement to job site with attached plastic or metal tags.
1. Place on each tag the mark number of the reinforcement corresponding to the mark number indicated on the shop drawings.
2. Mark numbers on tags to be so placed that the numbers cannot be removed.

2.8 TESTING

A. Perform at mill for each heat.

B. If requested by Engineer, furnish samples of each type of welded splice used in the Work in a quantity and of dimensions adequate for testing.

C. At the discretion of Engineer, radiographic testing of direct butt-welded splices will be performed. Provide assistance necessary to facilitate testing. Repair any weld which fails to meet the requirements of AWS D1.4. The costs of testing will be paid by Owner; except, the costs of all tests which fail to meet specified requirements shall be paid by Contractor at no increase in cost to Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Tolerances:
1. Rebar Placement:
a. Clear distance to formed surfaces: plus or minus ¼ inch.
b. Minimum spacing between bars: ¼ inch.
c. Top bars in slabs and beams:
1) Members 8 inches deep or less: plus or minus ¼ inch.
2) Members between 8 inches and 2 feet deep: plus or minus ¼ inch.
3) Members more than 2 feet deep: plus or minus ¾ inch.
d. Crosswise of members: Spaced evenly within plus or minus 1 inch.
e. Lengthwise of members: plus or minus 2 inches.
2. Minimum clear distance between rebars:
a. Beams, walls, and slabs: Distance equal to rebar diameter or 1 inch, whichever is greater.
b. Columns: Distance equal to 1-1/2 times the rebar diameter or 1½ inch, whichever is greater.
c. Beam and slab rebars shall be threaded through the column vertical rebars without displacing the column vertical rebars and still maintaining the clear distances required for the beam and slab rebars.

B. Minimum concrete protective covering for reinforcement, unless indicated otherwise on Contract Documents:
   1. Concrete deposited against earth: 3 inches.
   2. Formed surfaces exposed to weather or in contact with earth:
      a. 2 inches for reinforcing bars #6 or larger.
      b. 1½ inch for reinforcing bars less than #6.
   3. Formed surfaces exposed to any liquid: 2 inches for all rebar sizes.
   4. Interior surfaces:
      a. 1½ inch for beams, girders, and columns.
      b. ¾ inch for slabs, walls, and joists.

C. Splice steel to conform to Chapter 12 of ACI 318 or ACI 350 as applicable. Unless indicated otherwise on Contract Documents, provide splices for reinforcing as follows:
   1. Rebar:
      a. Lapped splices shall be not less than a Class B splice for reinforcement unless otherwise indicated.
      b. Mechanical splices shall be used whenever shown on the Contract Documents and may be used at other locations at Contractor's option. Such locations shall be shown specifically on the rebar shop drawings.
      c. Welding:
         1) Perform welding of rebars in accordance with requirements of AWS D1.4.
         2) Have each welder place an approved identifying mark near each completed weld.
   2. Welded wire fabric: Splice lap length measured between outermost cross wires of each fabric sheet shall not be less than 1 spacing of cross wires plus 2 inches, or less than 1.5 times the development length, nor less than 6 inches. Development length shall be as required for the basic development length for the specified fabric yield strength in accordance with Section 12 of ACI 318 or ACI 350.
   3. Provide splices of reinforcing not specifically indicated or specified subject to approval of Engineer.

D. Placing Rebars
   1. Assure that reinforcement at time concrete is placed is free of mud, oil, or other materials that may affect or reduce bond.
   2. Reinforcement with rust, mill scale, or a combination of both will be accepted as being satisfactory without cleaning or brushing provided dimensions and weights including heights of deformations on a cleaned sample are not less than required by applicable ASTM specifications that govern the rebar supplied.
   3. Rebar support:
      a. Support rebars and fasten together to prevent displacement by construction loads or placing of concrete.
      b. On ground, provide supporting concrete blocks.
      c. Over formwork, provide plastic-coated metal chairs, runners, boosters, spacers, hangers, and other rebar support. Only tips in contact with the forms need to be plastic coated.

d. Bars additional to those shown on the Contract Documents, which may be found necessary or desirable by Contractor for the purpose of securing reinforcement in position, shall be provided by Contractor at his own expense.
e. Tie securely at minimum of 33% of intersections with 16-gage or larger annealed iron wire.
f. Accommodate placement of formed openings.
g. Where parallel horizontal reinforcement in beams in indicated to be placed in two or more layers, rebars in the upper layers shall be placed directly above rebars in the bottom layer with clear distance between layers to be 1 inch. Place spacer rebars at 3 feet maximum centers to maintain the required 1-inch clear distance between layers.
h. Extend reinforcement to within 2 inches of concrete perimeter edges. If perimeter edge is earth formed, extend reinforcement to within 3 inches of the edge.
i. To insure proper placement, furnish templates for all column vertical bars and dowels.
j. Provide splices of reinforcement not specifically indicated or specified subject to Engineer's approval.
k. Do not bend reinforcement after embedding in hardened concrete unless approved by Engineer. Do not bend reinforcing by means of heat.
l. Tie wires shall be bent away from form surfaces.
m. Do not tack-weld reinforcement.

E. Ensure that steel reinforcement and embedments do not exceed 160 Degrees F at time of concrete placement.

3.2 FIELD QUALITY CONTROL

A. Reinforcement Congestion and Interfaces:
1. Notify Engineer whenever the specified clearances between rebars cannot be met.
2. Do not place any concrete until Engineer submits a solution to rebar congestion problem.
3. Rebars may be moved slightly to avoid interference with other reinforcement steel, conduits, or embedded items.
4. If rebars are moved more than 1 bar diameter, or enough to exceed above tolerances, obtain Engineer's approval of resulting arrangement of rebars.
5. No cutting of rebars shall be done without written approval of Engineer.

B. Employ a testing laboratory to perform and report following:
1. Review and approve Contractor proposed welding procedures and processes for conformance with AWS D1.4.
2. Qualify welders in accord with AWS D1.4.
3. Test three samples of each bar size and each type of weld in accord with AWS D1.4. The tensile strength of each test shall be not less than 125 percent of the required yield strength of the rebar tested.
4. Conduct nondestructive field tests (radiographic or magnetic particle) on not less than one random sample for each 10 welds. In addition, if any welds are found defective, test five previous welds performed by the same welder.

5. Visually inspect each weld for presence of cracks, undercuts, inadequate size, and other visible defects.

3.3 COORDINATION

A. Coordination with placement of formwork, formed openings, embedded items, and other Work.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Provide cast-in-place concrete work as shown on Contract Drawings and as specified herein.

B. Section includes:
1. Concrete Materials.
2. Proportioning and Mixing.
3. Ready Mixed Concrete.
4. Curing Materials.
5. Expansion Joint Filler.
6. Waterstops.
7. Liquid Floor Hardener.
8. Preparing for Concreting.
9. Placing of Concrete.
10. Finishing.
11. Curing.
12. Field Quality Control.

1.2 RELATED SECTIONS

A. Section 03 11 00 – Concrete Forming.

B. Section 03 20 00 – Concrete Reinforcing.

C. Section 03 60 00 – Grouting.

D. Section 07 13 26 – Membrane Waterproofing.

1.3 REFERENCES

A. American Concrete Institute (ACI) standards, most recent editions:

ACI 211	Standard Practice for Selecting Proportions for Concrete
ACI 211.2	Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 212	Chemical Admixtures
ACI 117	Standard Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete for Buildings
ACI 305	Recommended Practice for Hot Weather Concreting

ACI 306	Recommended Practice for Cold Weather Concreting
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures

B. ASTM International (ASTM) standards, most recent editions:

ASTM C31	Standard Specification Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specifications for Concrete Aggregates
ASTM C39	Test for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C94	Standard Specifications for Ready-Mixed Concrete
ASTM C143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C150	Standard Specifications for Portland Cement
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C260	Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C330	Standard Specification for Lightweight Aggregates for Structural Concrete; 2009
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C586	Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks as Concrete Aggregates (Rock-Cylinder Method)
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C827	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1293	Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
ASTM C1567	Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM D412	Test Methods for Rubber Properties in Tension
ASTM D624	Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D746	Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D747	Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam
ASTM D1751	Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2240	Test Method for Rubber Property - Durometer Hardness
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate

C. International Concrete Repair Institute (ICRI) standards, latest editions:

Guideline No 310.1R	Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
Guideline No 320.2R	Guide for selecting and specifying Materials for repair of Concrete Surfaces

D. NSF International (NSF), most recent edition:

NSF 61	Drinking Water System Components, Health Effects

E. U. S. Army Corps of Engineers standards, most recent editions:

CRD-C 572 PVC Waterstops

1.4 DEFINITIONS

A. Construction Joints: Fresh concrete placed against a hardened concrete surface; joint between two pours is called a construction joint. Unless otherwise indicated, provide construction joints with a waterstop and sealant groove of the shape indicated.

B. Expansion Joints: To allow concrete to expand freely, space provided between two pours, formed as indicated. Space is made by placing filler joint material against the first pour; acts as a form for the second pour.

C. Control Joints: Provide weakened plane in concrete, where shrinkage cracks will likely occur. A groove, shape and dimensions indicated in Drawings, formed or saw-cut in concrete. Groove is filled with joint sealant material.

D. Laitance: In placement of concrete, accumulation of small inert particles of cement and aggregate on surface, caused by excess of water that, when it evaporates, leaves a thin layer, causing weakened plane for subsequent pour.

E. Alkalies: Term "alkalies" referred to herein is defined as sum of percentage of sodium oxide and 0.658 times percentage of potassium oxide ($Na_20+0.658K_20$). These oxides shall be oxide content determined in accordance with ASTM C114.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Product data:
   1. Concrete mix design(s) proposed for use. Proposed concrete mix design submittal to include the following information:
      a. Sieve analysis and source identification of fine and coarse aggregates. Include sand equivalency.
      b. Source test results for aggregate organic impurities.
      c. Source test results for deleterious aggregate per ASTM standards.
      d. Proportioning of all materials.
      e. Type of cement with mill certificate for cement.
      f. Slump.
      g. Air Content.
      h. Brand, type, ASTM designation, and quantity of each admixture proposed for use.
      i. 28-day cylinder compressive test results of trial mixes per ACI 350 and as indicated herein.
      j. Shrinkage test results.
      k. Standard deviation value for concrete production facility.
   2. Manufacturer and type of joint filler, joint sealant, curing agent, and chemical floor hardener.

3. Waterstops:
    a. Provide manufacturer's current test reports with written material certification.
    b. Provide samples of extruded or molded sections of each size or shape to be used in the Work. Samples shall represent in all aspects, the material to be furnished under this Contract.
    c. Provide sample of fabricated cross-construction of each size or shape of waterstop to be used. Fabricate samples so that material and workmanship represent the materials to be furnished in the Work.
    d. Provide manufacturer's written certification as an integral part of the shipping form, to show that the material shipped to Work meets or exceeds the physical property requirements specified.
4. Manufacturer and type of bonding and patching mortar and bonding adhesive used at construction joints.
5. Pour plan for superplastisized concrete pours.

1.6 CONCRETE CONFERENCE

A. A meeting to review the detailed requirements of the Contractor's proposed concrete design mixes and to determine the procedures for producing proper concrete construction shall be held no later than 14 days after the notice to proceed.

B. All parties involved in the concrete work shall attend the conference, including the following:
1. Contractor's representative
2. Testing laboratory representative
3. Concrete subcontractor
4. Reinforcing steel subcontractor and detailer
5. Concrete supplier
6. Admixture manufacturer's representative

C. The conference shall be held at a mutually agreed upon time and place. The Engineer shall be notified no less than 5 days prior to the date of the conference.

1.7 QUALITY ASSURANCE

A. Preconstruction Testing: Perform all preliminary and trial batch laboratory tests on cement, aggregates, and concrete.

B. Testing Agencies: The testing laboratory shall meet or exceed the requirements of ASTM C1077.

1.8 DELIVERY, STORAGE AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Mixing, transporting, handling, placing, curing and testing of concrete in accordance with applicable ACI and ASTM specifications and as specified.

C. Storage of material:

1. Cement:
    a. Protect cement from exposure to moisture until used.
    b. Do not use if caked or lumpy.
    c. Store sacked cement to permit access for inspection and sampling.
2. Aggregate:
    a. Store to prevent segregation and contamination with other sizes or foreign materials.
    b. Obtain samples for testing from aggregates at point of batching.
    c. Do not use frozen or partially frozen aggregates.
    d. Do not use the bottom 6 inches of stockpiles in contact with ground.
    e. Allow sand to drain until moisture content is uniform prior to use.
3. Admixtures:
    a. Protect from contamination, evaporation, freezing, or damage.
    b. Maintain within temperature range recommended by manufacturer.
    c. Completely mix solutions and suspensions prior to use.

D. Delivery:
1. Prepare a delivery ticket for each load of ready-mix concrete delivered to the project. Truck operator shall hand ticket to Engineer at time of delivery, which shows the following information for each load:
    a. Mix identification mark.
    b. Quantity delivered (by volume).
    c. Amount of each material in batch.
    d. Outdoor temperature in the shade.
    e. Time at which cement was added.
    f. Amount of water added at jobsite by Contractor.
    g. Amount of superplastisizer added where applicable.

1.9 SITE ENVIRONMENTAL REQUIREMENTS

A. When temperature is below 40°F or is likely to fall below 40°F during 24-hour period after placing concrete, heat materials, (not in excess of 140°F) including both water an aggregates and protect concrete so that temperature of the concrete is between 50°F and 90°F for 24-hour period after placing concrete.

B. During hot weather, shade materials from sun and use cool water so temperature of concrete does not exceed 90°F at time of placing concrete.

C. Placing of concrete is not permitted where, in opinion of Engineer, wind, rain or inadequate facilities furnished by Contractor prevents proper finishing or curing of concrete.

1.10 COORDINATION

A. Coordination with placement of reinforcing steel, embedded items, and other Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Expansion joint fillers:
   a. Ceramar, WR Meadows, Inc.
   b. Rubatex Corporation
   c. Williams Products, Inc.
   d. Engineer approved equal.
2. Membrane Curing Compound.
   a. 1100-Clear, WR Meadows, Inc.
   b. Dry-Chem Rez Cure (J-11-W), Dayton Superior.
   c. L&M Cure R, L&M Construction Chemicals, Inc
   d. Engineer approved equal.
3. Evaporation Retardant:
   a. AquaFilm, Dayton Superior.
   b. Eucobar, Euclid Chemical Company.
   c. MasterKure ER50 by Master Builders.
   d. Engineer approved equal.
4. Waterstops, Plastic Serrated Type:
   a. Vinylex Corporation.
   b. Greenstreak, Inc.
   c. W. R. Meadows, Inc.
   d. Engineer approved equal.
5. Waterstops, Plastic Adhesive Type:
   a. Synko-Flex, Henry Company.
   b. Engineer approved equal.
6. Waterstops, Hydrophilic Type
   a. Adcor ES, WR Grace,
   b. Hydro-Flex, Henry Company.
   c. Hydrotite, Greenstreak, Inc.
   d. Engineer approved equal.
7. Bonding agent:
   a. Armatek 110 EpoCem, Sika Corporation
   b. Engineer approved equal.
8. Set Controlling Admixtures:
   a. For air temperature at the time of placement over 80°F; set-retarding;
      1) Plastocrete, Sika Corporation
      2) Pozzolith 300R, Master Builders.
      3) Engineer approved equal.
   b. For air temperature at the time of placement under 40°F: Non-corrosive set accelerating;
      1) Plastocrete 161FL by Sika Corporation.
      2) Pozzutec 20 by Master Builders.
9. Air-entraining Agent:
   a. Micro-Air, Master Builders.
   b. Daravair 1000, WR Grace.

c. Sika AEA-15, Sika Corporation.
d. Engineer approved equal.

10. Pigments for Underground Conduit Banks:
    a. Arizona Oxides, #1835.
    b. Bayer, Bayferrox #130.
    c. Davis, #117.
    d. As currently approved by governing agency.
11. Liquid Chemical Floor Hardener:
    a. Surfhard, Euclid Chemical Company, Cleveland, Ohio.
    b. Burke-O-Lith, EDOCO.
    c. Solidus Hardener, Lambert Corporation.
    d. Engineer-approved equal.

2.2 MATERIALS

A. Portland cement: Comply with ASTM C150, Type II or V.
1. Portland cement shall contain not more than 0.60 percent equivalent alkalies.
2. Single brand of cement used throughout Work; brand approved by Engineer.

B. Fly Ash: ASTM C618, Class F including supplementary optional requirements relating to reactive aggregates and alkalis, and loss on ignition (LOI) not to exceed 5 percent
1. Maximum of 25 percent replacement at 1.0 pounds of fly ash per pound of cement replaced.

C. Coarse Aggregate: Conforming to ASTM C33 and as noted below.
1. Clean, hard, durable gravel, crushed gravel, crushed rock or combination thereof.
2. Reactivity: Non-reactive or below innocuous behavior level.
3. Prepare and handle coarse aggregates in two or more size groups for combined aggregates with maximum size greater than 3/4 inch.
4. When aggregates are proportioned for each batch of concrete, combine the size groups.
5. Obtain coarse aggregates from sources approved by Engineer.

D. Lightweight Aggregate: ASTM C 330, 3/4-inch nominal maximum aggregate size.

E. Combined Aggregates: Well graded from course to fine sizes; uniformly graded between screen sizes to produce a concrete that has optimum workability and consolidation characteristics. Where a trial batch is required for a mix design, the final combined aggregate gradation will be established during the trial batch process.

F. Fine Aggregates: Natural or combination of natural and manufactured sand that is hard and durable.
1. Lightweight Sand for Fine Aggregate: Not permitted.
2. Sand Equivalency: Tested in accordance with ASTM D2419; not less than 80 percent for an average of 3 samples; not less than 80 percent for an individual test.
3. Gradation: In accordance with ASTM C33; 15 to 30 percent passing number 50 screen; 5 to 10 percent passing number 100 screen.
4. Fineness Modulus: Not over 3.00.
5. Reactivity: Non-reactive or below innocuous behavior level.

6. Obtain fine aggregates from sources approved by Engineer

G. Water: Clean and free from objectionable quantities of organic matter, alkali, salts and other impurities, as determined by Engineer.

H. Admixtures:
1. Maximum total water soluble chloride ion content contributed from all ingredients of concrete including water, aggregates, cementitious materials, and admixtures by weight percent of cement shall not exceed 0.10.
2. Do not use calcium chloride.
3. Provide admixtures of same type, manufacturer, and quantity as used in establishing required concrete proportions in the mix design.
4. Air entraining admixtures: ASTM C260.
5. Water reducing admixtures:
   a. Comply with ASTM C494, Type A.
   b. Concrete not to contain more than one water-reducing admixture.
   c. Conform to applicable provisions of ACI 212.3R.
   d. Follow manufacturer's instructions.
   e. Use chloride free admixtures only.
6. Set controlling admixtures with or without water-reducing properties.
   a. ASTM C494, Types B through E.
   b. Conform to applicable provisions of ACI 212.3R.
   c. Do not use retarding or accelerating admixtures unless specifically approved in writing by Engineer and at no additional cost to Owner.
   d. Follow manufacturer's instructions.
   e. Use chloride free admixtures only.
7. High Range Water Reducers:
   a. In accordance with ASTM C494, Type F.
   b. Conform to applicable provisions of ACI 212.3R.
   c. Locations for use of high range admixtures shall be as shown on the Contract Drawings. Do not use high range admixtures in other locations unless specifically approved by Engineer and at no additional cost to Owner.
   d. Add to concrete at the jobsite after all other ingredients have been mixed and initial slump has been verified.
   e. Added by a technician certified by manufacturer of the product.
   f. Added at the site unless written permission is given by Engineer to add the product at plant.
   g. Mixing: Minimum 70 revolutions or 5 minutes after addition of high-range water reducer.
   h. Slump before Addition: Maximum 2 inches.
   i. Slump after Addition: Minimum of 6 inches and maximum of 10 inches.
8. Pigments for Underground Conduit Banks: Pigment shall be added to concrete encasing electrical duct banks as required by governing agency.

I. Curing Materials
1. Polyethylene sheet for use as concrete curing blanket shall be white and shall have a nominal thickness of 6 mils. The loss of moisture when determined in accordance with the requirements of ASTM C156 shall not exceed 0.055 grams per square centimeter of surface.

2. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, having a nominal thickness of 2 mils and permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU B 790A (1) (2). The loss of moisture, when determined in accordance with the requirements of ASTM C156, shall not exceed 0.055 gram per square centimeter of surface.
3. Polyethylene-coated burlap for use as concrete curing blanket shall be 4 mils thick, white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of moisture, when determined in accordance with the requirements of ASTM C156, shall not exceed 0.055 gram per square centimeter of surface.
4. Membrane Curing Compound (with fugitive dye added): ASTM C309, Type 1-D, Class B. Sodium silicate compounds shall not be allowed.

J. Expansion Joint Filler
1. Provide expansion joints in concrete construction where shown on Contract Drawings.
2. Expansion Joint Filler: Preformed, non-extruding, resilient type, constructed of cellular sponge rubber, extending full thickness of slab, in accordance with ASTM D1751 or ASTM D1752, Type I.

K. Grout: As specified in Section 03 60 00 – Grouting.

L. Waterstop, Plastic Serrated Type:
1. Extruded elastomeric polyvinyl chloride compound; containing plasticizers, resins, stabilizers and other materials necessary to meet requirements of Specifications.
   a. Store waterstops to permit free circulation of air around waterstop material.
   b. Provide special fittings fabricated for splices and joints.
   c. In accordance with Specification CRD-C572.

	VALUE	ASTM STD.
PHYSICAL PROPERTY, SHEET MATERIAL		
Tensile Strength-minimum (psi)	1750	D412, Die C
Ultimate Elongation-minimum (%)	350	D412, Die C
Low Temp. Brittle-maximum (°F)	-35	D746
Stiffness in Flexure-minimum (psi)	400	D747
ACCELERATED EXTRACTION (CRD-C572)		
Tensile Strength-minimum (psi)	1500	D412, Die C
Ultimate Elongation-minimum (%)	300	D412, Die C
EFFECT OF ALKALIES (CRD-C572)		
Change in Weight (%)	+.25/-.10	-----
Change in Durometer, Shore A	+5	D2240
FINISHED WATERSTOP		
Tensile Strength minimum (psi)	1400	D412, Die C
Ultimate Elongation minimum (%)	280	D412, Die C

   d. Style:
      1) Centerbulb, 7/8 inch OD, 6 inches long.
      2) Flat Strip, 6 inches long unless noted otherwise.

M. Waterstop, Plastic Adhesive Type: Non expansive plastic adhesive strip type conformable, manufactured solely for the purpose of preventing water from passing through construction joints.
   1. Primer as recommended by waterstop manufacturer.

N. Waterstop, Hydrophilic Type: Expansive, conformable blended rubber based material.
   1. Primer as recommended by waterstop manufacturer.

O. Liquid Chemical Floor Hardener:
   1. Colorless, aqueous solution of containing magnesium fluosilicate combined with a wetting agent.
      a. Premeasured, premixed, and packaged at the factory
      b. Not less than 2 pounds fluosilicate per gallon.
      c. Provide material which does not react with, inhibit, or otherwise interfere with adhesives and bonding of future floor finishes.

P. Elastomeric Bearing Materials:
   1. Rubber bearing pads shall be furnished with the dimensions, material properties, and elastomer grade as required by the Drawings and in accordance with ASTM D2240, Type A, Shore 30 or 40 Durometer.
   2. Prepare concrete support surfaces and adhere pads to concrete per manufacturer's recommendations.

Q. Waterproofing: Refer to Section 07 13 26 – Membrane Waterproofing.

2.3 EQUIPMENT

A. On-Site Batch Plants:
   1. Direct weighing equipment approved by Engineer for measuring cement and aggregate. Scales certified by Bureau of Weights and Measures. Certification current within 6 months.
   2. Equip mixer with suitable water meter or other measuring device approved by Engineer.
      a. Meter capable of measuring water in variable amounts within a tolerance of 1 percent.
      b. Water feed control mechanism capable of being locked in position to deliver constantly supply of specified amount of water to each batch of concrete.
      c. Meter equipped with setback register with a readily visible vertical face and double hands indicating in cubic feet and decimals.
      d. Provide with positive, quick-acting cut-off valve in the water line to the mixer. Operating mechanism must not leak when valves are closed.
   3. Batch mixer of an approved type and size, designed to ensure uniform distribution of all component materials throughout the mass during the mixing operation. Install and use a batch timer and counter, including lock release and audible indicator on each concrete mixer.

B. Concrete Pumps:

1. Provide pumping equipment with two cylinders, designed to operate with only one cylinder in case one is not functioning. In lieu of this requirement, provide a standby pump on the site during pumping.
    a. Minimum Diameter of Hose (conduit): 4 inches.
    b. Aluminum conduits for conveying the concrete will not be permitted.

C. Vibrators:
1. Internally vibrated, high speed power vibrators of an approved immersion type. In sufficient numbers with standby units as required.

D. Truck Mixers:
1. At the Contractor's option, ready-mixed concrete may be used meeting the requirements as to materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C94, including the following supplementary requirements.
2. Ready-mixed concrete shall be delivered to the site of the Work, and discharge shall be completed within 90 minutes after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever is first.
3. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.
4. Mix each batch of concrete in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.
5. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the specified slump is 3 inches or less, or if they differ by more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the Work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.
6. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the Engineer.

2.4 REINFORCEMENT STEEL

A. Provide in accordance with Section 03 20 00 – Concrete Reinforcing.

2.5 CONCRETE MIXES

A. General: Concrete shall be composed of cement, admixtures, aggregates and water. These materials shall be of the qualities specified and in accordance with ACI 301 specifications. The exact proportions in which these materials are to be used for different parts of the Work will be determined during the trial batch. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items. The proportions shall be changed whenever necessary or desirable to meet the required results at no additional cost to the Owner. All changes shall be subject to review by the Engineer.

B. Fine Aggregate Composition:

1. In mix designs for structural concrete, the percentage of fine aggregate in total aggregate by weight shall be as indicated in the following table:

Fineness Modulus	Maximum Percent
2.7 or less	41
2.7 to 2.8	42
2.8 to 2.9	43
2.9 to 3.1	44

2. In all other concrete, the maximum percentage of fine aggregate of total aggregate, by weight, shall not exceed 50.

C. Concrete compressive strength, aggregate size and slump in accordance with the following:

Type of Construction	Compressive Strength (psi)	Aggregate Gradation (ASTM C33)	Slump in Inches (Max.)	Max W/C Ratio (by Weight)
Structure walls, slabs on grade and suspended slabs.	4,500	#67 (3/4")	4	0.45
Structure footings.	4,500	#467 (1-1/2")	4	0.45
Lightweight Concrete on Metal Deck	4,000	Lightweight (ASTM 330)	4	0.45
Reinforced concrete encasements; thrust blocks	4,000	#467 (1-1/2")	4	0.50
Site Slabs; Curb and gutter	4,000	#67 (3/4")	4	0.50
Lean Concrete	3,000	#467 (1-1/2")	5	0.60
Site underground conduit banks: Min. 3 lbs. red pigment/sack cement	3,000	#8 (3/8")	5	0.60

1. Compressive Strength: minimum at 28 days of age.
2. Slump as shown above shall be plus or minus 1 inch.
    a. Slump to be measured before addition of any plasticizing agents at the job site.
    b. Measure at point of discharge of the concrete into the concrete member per ASTM C143.
    c. Concrete of lower than maximum slump may be used provided it can be properly placed and consolidated.
    d. For pumped concrete, provide additional water at batch plant to allow for slump loss due to pumping. Provide only enough additional water so that slump of concrete at discharge end of pump hose does not exceed maximum slump specified above.
3. Minimum cement content:
    a. Reinforced Concrete: Six sacks Portland Cement per cubic yard.
    b. Unreinforced Concrete: Five sacks Portland Cement per cubic yard.
4. Air content: Provide air entrainment resulting in a total air content of 4 to 7 percent for all types of construction.
    a. Air content to be measured in accordance with ASTM C231, ASTM C173, or ASTM C138.
    b. Air may be omitted from interior slabs.
5. For Lightweight concrete maximum dry unit weight: 115 lb per cubic foot.

D. Selection of Proportions:
1. General: Proportion ingredients to produce proper workability, durability, strength, and other required properties. Prevent segregation and collection of excessive free water on the surface.
2. Pan stair fill:
    a. Coarse aggregate: 100 percent passing a 1/2 inch sieve.
    b. Proportions:
        1) One sack cement.
        2) 150 pounds coarse aggregate.
        3) 150 pounds fine aggregate (sand).
        4) Adjust mix to obtain satisfactory finishing.
3. Submit mix design data for approval as required by this specification Section.
4. Proportion mixture to provide desired characteristics using one of the methods described below:
    a. Method 1 (Trial Mix): Per ACI 350, Chapter 5, except as modified herein.
        1) Air content within range specified above.
        2) Record and report the temperature of trial mixes.
        3) Proportion trial mixes per ACI 211.1.
    b. Method 2 (Field Experience): Per ACI 350, Chapter 5, except as modified herein.
        1) Field test records must be acceptable to Engineer to use this method.
        2) Test records shall represent materials, proportions, and conditions similar to those specified herein.
    c. Required average strength to exceed the specified 28-day compressive strength by the amount determined or calculated in accordance with the requirements of ACI 350, using the standard deviation of the proposed concrete production facility.
5. Shrinkage Limitation

a. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age shall be 0.036 percent or 0.042 percent, respectively per ASTM C157. Use a mix design for construction that has first met the trial batch shrinkage requirements. Shrinkage limitations apply only to structural concrete.

2.6 SOURCE QUALITY CONTROL

A. Trial Batch: Based on submitted concrete mixes for each class of concrete.

B. Aggregates:

1. Fine and coarse aggregates shall be tested in accordance with ASTM C1260 or ASTM C1293 to show compliance with ASTM C33 for alkali-silica reactivity and the aggregates shall be non-reactive.
2. Fine and coarse aggregates shall be tested in accordance with ASTM C1260 or ASTM C1293 to show compliance with ASTM C33 for alkali-silica reactivity and shall be non-reactive unless employing the following additional measures:
   a. When the above test results show the aggregates to be reactive, and fly ash or other supplementary cementing material (SCM) is approved for use in order to control alkali-aggregate reactivity, the proposed concrete mixture shall be tested in accordance with ASTM C1567 and produce expansion results of less than 0.10 percent at 14 days.
   b. When a lithium admixture is approved for use in order to control alkali-aggregate reactivity, the proposed concrete mixture shall be tested in accordance with ASTM C1293 and produce expansion results of less than 0.04 percent at one year.
3. The fine and coarse aggregates shall be tested in accordance with ASTM C586 to show compliance with ASTM C33 for alkali-carbonate reactivity and shall be non-reactive.
4. The fine aggregate shall be tested in accordance with ASTM C40 to show compliance ASTM C33 for organic impurities.
5. The fine and coarse aggregate shall be tested in accordance with ASTM C88 to show compliance with ASTM C33.
6. The fine and coarse aggregate shall be tested in accordance with ASTM C142 to show compliance with ASTM C33.
7. The fine and coarse aggregate shall be tested in accordance with ASTM C123 to show compliance with ASTM C33.
8. The fine and coarse aggregate shall be tested in accordance with ASTM C117 to show compliance with ASTM C33.
9. The coarse aggregate shall be tested in accordance with ASTM C131 to show compliance with ASTM C33.
10. In addition to initial aggregate testing, each type of aggregate shall be tested at no increased cost to the Owner for conformance to ASTM C33 under any of the following conditions:
    a. Concrete placement extending longer than six months.
    b. There is a noticeable change in aggregate appearance, consistency, or ease of excavation.
    c. The aggregate supplier changes pits, or locations in the original pit.
11. If the test results fail to meet the requirements of ASTM C33 and this Section, the Engineer may stop the placement of concrete, and may require additional testing of

aggregates or field and trail batch testing of concrete to verify conformance to ASTM C33 and the strength and shrinkage requirements of this Section.

12. The Engineer may conduct any additional testing of aggregates at anytime during the concrete placement period. Depending on the test results, testing cost shall be paid by the Contractor or Owner, according to the General Conditions. If test data fails to conform to ASTM C33, the Engineer may stop the placement of concrete or take corrective actions as indicated above.

PART 3 - EXECUTION

3.1 PREPARING FOR CONCRETING

A. Earth surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. Surface shall be free from standing water, mud and debris at the time of placing concrete.

B. Construct forms to the shape, lines and dimensions of members shown on Drawings and sufficiently tight to prevent leakage of mortar. Take special care when forming concrete containing high range water reducing agents. Brace and tie forms to maintain position and shape.

1. Before placing concrete containing superplastisizing agents, Contractor shall submit a Pour Plan to Engineer for approval. The Engineer may require additional manpower or equipment for these pours as required to limit defects in the concrete. The Pour Plan shall include the following:
   a. Number of crew members and assignment of each.
   b. Number of vibrators to be used.
   c. Number of vibrators in reserve.
   d. Time of day and anticipated duration of pour.
   e. Type and capacity of pumping equipment if used.

C. Provide slabs and beams of minimum indicated depth when sloping foundation base slabs or elevated floor slabs to drains.

1. For slabs on grade, slope top of subgrade to provide floor slabs of minimum uniform indicated depth.
2. Do not place floor drains through beams.

D. Unless otherwise indicated, provide exterior corners in concrete members with 3/4-inch chamfers. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

E. Complete all formwork, installation of parts to be embedded, reinforcement and surface preparation prior to placing concrete.

1. Use setting diagrams, templates, and instructions for locating and setting embedments and attachments.
2. Prior to placing concrete, position and support pipe, conduit, dowels and other ferrous items required to be embedded, to ensure a 2-inch minimum clearance between items and any part of concrete reinforcement.

3. Securing such items in position by wiring or welding to reinforcement is prohibited.
4. Electrical conduits and piping:
    a. Install between layers of reinforcement steel in walls and slabs with steel in both faces.
    b. Install under reinforcement steel in slabs with only one layer of steel.
    c. Conduit may be run in concrete members or slabs with permission of the Engineer, provided the outside diameter does not exceed 1/3 of the thickness of the concrete. Locate such conduit in the center of the concrete or where the minimum concrete cover will be 1 conduit diameter. Space conduits at least 3 diameters apart on centers. As a general rule, conduit may not cross other conduit at pipe in concrete members or slabs.

F. Provide openings in formwork to accommodate other trades. Accurately place and securely support all items built into forms.

G. Waterstops:
1. Preparation
    a. Uncoil waterstop minimum of 24 hours prior to installation for ease of handling and fabrication.
    b. Position waterstop to ensure proper distance from steel reinforcing bars and to prevent rock pockets and honeycomb.
    c. Clean concrete joint and waterstop after first pour to remove debris and dirt.
2. Installation
    a. Position waterstop across joints as specified herein and as indicated on Drawings.
    b. Center waterstops on joint unless shown otherwise.
    c. When centerbulb is present at moving joints, ensure that it is not embedded.
    d. All waterstops fully continuous for the extent of the joint.
    e. Secure plastic serrated waterstop in correct position before concrete placement with hog rings and wire to adjacent reinforcing steel at 12-inch maximum spacing. Center-to-center spacing may be increased upon written request and approval of Engineer.
    f. Take suitable precautions and means to support and protect waterstops during the progress of the work.
    g. Carefully place concrete without displacing waterstop from proper position.

H. Construction, Expansion, and Contraction Joints:
1. Provide at locations indicated or as approved by Engineer.
2. Install construction joints in beams, slabs, and girders perpendicular to the planes of their surfaces.
3. At least 48 hours shall elapse between placing of adjoining concrete construction.
4. Before new concrete is placed against existing concrete, coat all construction joints with an approved bonding adhesive used and applied in accordance with manufacturer's instructions.

I. Thoroughly clean surfaces of metalwork to be in contact with concrete immediately before concrete is placed.

J. Remove ponded water from the excavation and moisten fill.

K. Remove laitance, tighten forms, roughen, clean, wet and slush hardened concrete with cement grout prior to placing fresh concrete at construction joints. Coat form surfaces with form release agents prior to placing reinforcing bars in forms.

3.2 CYLINDER STORAGE DEVICE

A. Provide and maintain a cylinder storage device at a protected location on the Site, acceptable to Engineer and as follows:
   1. Maintain concrete test cylinders at a temperature range of 60 degrees F to 80 degrees F for the initial 24-hour curing period.
   2. Once placed in the storage device, do not move the cylinders during this period.
   3. Equip the storage device with an automatic 24-hour temperature recorder that continuously records on a time/temperature chart with an accuracy of ±1 degree F.
   4. Have the storage device available at the point of use at least 24 hours before concrete placement.
   5. A 24-hour test run may be required before placement of concrete.

B. Engineer may stop placement of concrete if the storage device cannot accommodate the required number of test cylinders.

C. Use water containing hydrated lime if water is to be in contact with cylinders.

3.3 PLACING OF CONCRETE

A. Notify Engineer not less than 24 hours in advance of the times and places at which Contractor intends to place concrete.

B. Place concrete in compliance with ACI Specifications and requirements of this Section.

C. Place concrete only in presence of duly authorized representative of Engineer.

D. Ready Mix Equipment:
   1. Do not exceed manufacturer's rated capacity of the mixer.
   2. Ensure sufficient mixing time for uniform distribution of materials.
   3. Discharge all concrete from mixer prior to mixing new batch.
   4. In accordance with ASTM C94.

E. Transporting:
   1. Transport concrete from mixer to place of deposit by methods, which prevent segregation or loss of material.
   2. Provide runways when wheelbarrows are used to transport concrete.
   3. Do not wheel conveying equipment over reinforcement or support runways on reinforcement.

F. Placing:
   1. Deposit concrete in continuous manner and as rapidly as possible within planned joints or sections.
   2. Do not use concrete that has attained initial set or contained mixing water for more than 1 hour.

3. Uniformly distribute concrete during process of depositing and in no case move deposited concrete in forms more than 6 feet in horizontal direction.
4. Do not drop freely more than 5 feet in unexposed work or more than 3 feet in exposed work; where greater drops are required, use duct or other approved method.
5. Do not place concrete against icy or frost covered earth surfaces.

G. Compacting:
1. Compact by internal type vibrators supplemented by rodding and tamping as necessary, to maximum practicable density, free from pockets of coarse aggregate in such a manner that surfaces are smooth and free from voids.
2. Avoid excessive vibration of concrete; avoid segregation of aggregates.
3. Avoid disturbance of previous lifts where initial set has taken place.
4. Use of form vibrators or tapping of forms is prohibited.

H. Protection:
1. Protect all concrete against physical injury until final acceptance by Owner.
2. Protect concrete from reduced strength due to weather extremes.
3. When the temperature is below 40 Degrees F, or is likely to fall below 40 Degrees F during the 24-hour period after placing the concrete, follow the recommendations of ACI 306R, except as modified herein.
   a. Do not place concrete on frozen ground or in contact with forms or reinforcing bars coated with frost, ice, or snow.

Outdoor Temperature at Placement (In shade)	Concrete Temperature (At mixing)
Below 30 Degrees F	65 Degrees F
Between 30 and 45 Degrees F	60 Degrees F
Above 45 Degrees F	50 Degrees F

   b. Minimum concrete temperature at the time of mixing:
   c. Do not place heated concrete that is warmer than 80 Degrees F.
   d. If freezing temperatures are expected during curing, maintain the concrete temperature at or above 50 Degrees F for 72 hours, with additional requirements listed under Article 3.3 - Curing below.
   e. Do not allow concrete to cool suddenly.
   f. Calcium chloride will not be permitted as a concrete accelerator or to thaw frozen subgrade prior to concrete placement.
4. When the temperature is 90 Degrees F or above, or is likely to rise above 90 Degrees F within the 24-hour period after concrete placement; or when there is any combination of high air temperature, low relative humidity, and wind velocity which would impair concrete strength or quality, follow the recommendations of ACI 305R and the following:
   a. Keep concrete as cool as possible during placement and curing.
   b. Do not allow concrete temperature to exceed 90 Degrees F at placement.
   c. Prevent plastic shrinkage cracking due to rapid evaporation of moisture.
   d. Dampen subgrade and forms with cool water immediately prior to placement of concrete.
   e. Apply an evaporation retardant per manufacturer's instructions between placement and finishing operations.

f. Protect the concrete with temporary wet covering during any appreciable delay between placement and finishing.

g. Take appropriate precautions per ACI 305R when the actual or anticipated evaporation rate equals or exceeds 0.2 LBS/SF/HR as determined from ACI 305R.

3.4 CURING

A. Cure concrete for not less than 14 days after placing.

B. Leave forms in place at least 14 days, or until concrete has attained specified 28-day strength, unless otherwise approved by Engineer. If forms are allowed to be removed within 14 days of placing concrete, continue curing in accordance with other methods specified herein or as directed by Engineer.

C. Strictly follow careful procedures for the removal of forms and perform with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted.

D. Keep encasement concrete, concrete cradles and anchor blocks moist until covered. The surface shall be covered with moist earth not less than 4 hours, or more than 24 hours, after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 days after placement of concrete.

E. Concrete slabs may be cured by either of the following two methods:

1. Method 1:
   a. After finishing slab, wet surface with a fine spray of water and cover with polyethylene-bonded waterproof paper sheeting.
   b. Lap sheets 4 inches at sides and ends and seal with adhesive tape to form a continuous watertight joint.
   c. Weigh sheeting down with wood planks to keep sheeting in contact with concrete.
   d. Repair or replace sheets immediately if damage occurs.
2. Method 2:
   a. Cover concrete with water-saturated polyethylene-coated burlap curing mats and keep continuously wet for curing period.
   b. Lap sheets 4 inches at sides and ends and seal with adhesive tape to form a continuous watertight joint.
   c. Weigh sheeting down with wood planks to keep sheeting in contact with concrete.
   d. Repair or replace sheets immediately if damage occurs.

F. As an alternate to above referenced curing methods for formed and slab concrete, spray surface with liquid curing compound that does not affect bond of paint to concrete surface.

1. Apply curing compound in accordance with manufacturer's instructions as soon as the concrete has hardened enough to prevent marring on unformed surfaces, and within 2 hours after completion of finish or stripping of forms, if stripped in less than 14 days.
   a. Maximum coverage rate of 200 square feet per gallon, applied in such a manner as to cover surface with a uniform film to seal thoroughly.

2. Curing vertical surfaces with a curing compound:
   a. Cover vertical surfaces with a minimum of two coats of the curing compound.
   b. Apply the first coat of curing compound immediately after form removal. Vertical surface at the time of receiving the first coat shall be damp with no free water on the surface.
   c. Allow the preceding coat to completely dry prior to applying the next coat.
   d. Vertical surface is defined as any surface steeper than 1 vertical to 4 horizontal.
3. Curing Compound: As specified herein.
4. Take care to avoid damage to seal during curing period.
5. Repair broken or damaged seals occurring before expiration of curing period by application of additional curing compound over damaged portion.
6. Do not use curing film method where construction joints are to be made.
7. In hot weather, follow curing procedures outlined in ACI 305R and the following:
   a. Begin curing unformed surfaces immediately after finishing and continue for 24 hours. Curing shall consist of application and maintenance of water saturated material to all exposed surfaces; horizontal, vertical, and otherwise. After 24-hour interval, continue curing, using one of the following methods:
      1) Moist cure for six more days.
      2) Application of curing compound as specified above.
   b. Begin curing formed concrete immediately after placing. Curing shall consist of keeping forms continuously wet for 24 hours. Thereafter, continue curing, using one of the following methods:
      1) Loosen forms and position soaker hose so that water runs down along concrete surfaces. Continue for six more days.
      2) Strip forms and apply during compound as specified for vertical surfaces above. Do not allow concrete surfaces to dry prior to application of curing compound.
8. In Cold Weather, following curing procedures outlined in ACI 306R and the following:
   a. Water curing of concrete may be reduced to 6 days during periods when the mean daily temperature in the vicinity of the worksite is less than 40 degrees F; provided that, during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing shall be temporarily discontinued.
   b. Concrete cured by an application of curing compound will require no additional protection from freezing if the protection at 50 Degrees F for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces; otherwise the concrete shall be protected against freezing temperatures for 72 hours immediately following 72 hours protection at 50 Degrees F. Concrete cured by water curing shall be protected against freezing temperatures for 72 hours immediately following the 72 hours of protection at 50 Degrees F.
   c. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40 Degrees F in 24 hours. In the spring, when the mean daily temperature rises above 40 Degrees F for more than 3 successive days, the specified 72-hour protection at a temperature not lower than 50 degrees F may be discontinued for as long as the mean daily temperature remains above

40 Degrees F; provided, that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.

d. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. Use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound; provided, that the use of curing compound for such surfaces is otherwise permitted by these Specifications.

3.5 TREATMENT OF SURFACE DEFECTS

A. As soon as forms are removed, all exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the Engineer. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall have them repaired as specified herein. Concrete containing extensive voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced. All repairs and replacements herein specified shall be promptly executed by the Contractor at its own expense.

B. All repairs shall be performed in accordance with the manufacturer's recommendations and with ICRI Guideline No 310.1R and Guideline No 320.2R. These guidelines shall be followed for removal geometry, exposing and undercutting of reinforcing steel, cleaning and repair of reinforcing steel, and edge and surface condition of concrete and shall be followed regardless of the amount of corrosion present or not present in the reinforcing steel.

1. Remove unsound deteriorated concrete from Work by high pressure water blasting machines capable of scoring concrete surfaces to minimum amplitude roughness of 3/16-inch. Remove to provide for minimum thickness specified for mortar. If reinforcing is exposed in this process, then additional concrete shall be removed until the surface is a minimum of 1-inch or 1 bar diameter behind the exposed reinforcing.
2. Clean exposed reinforcing bars of rust and other deleterious materials which may prevent bonding of the repair product.
3. Keep surface at saturated surface dry (SSD) condition for a minimum of 24-hours prior to placement of repair material.
4. Place and cure repair grout as specified in Section 03 60 00 – Grouting and in accordance with manufacturer's written recommendations.
5. For exposed walls, the cement shall contain such a proportion of white Portland cement as is required to make the color of the patch match the color of the surrounding concrete.

C. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. These holes then shall be repaired in an approved manner with dry-packed cement grout specified in Section 03 60 00 - Grouting. Holes left by form-tying devices having a rectangular cross-section, and other imperfections having a depth greater than their least surface dimension, shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout specified in Section 03 60 00 - Grouting.

D. All repairs shall be built up and shaped in such a manner that the completed Work will conform to the requirements of this Section, as applicable, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of said repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

E. Prior to filling any structure with water, all cracks that may have developed shall be "vee'd" as shown on the Drawings and filled with sealant conforming to the requirements of Section 07 92 00 – Joint Sealants. This repair method shall be done on the water bearing face of members. Prior to backfilling, faces of members in contact with fill, which are not covered with a waterproofing membrane, shall also have cracks repaired as specified herein.

3.6 PATCHING HOLES IN CONCRETE

A. Patching Small Holes
   1. Holes which are less than 12 inches in their least dimension and extend completely through concrete members, shall be filled as specified herein.
   2. Small holes in members which are water-bearing or in contact with soil or other fill material, shall be filled with nonshrink grout specified in Section 03 60 00 - Grouting. Where a face of the member is exposed to view, the nonshrink grout shall be held back 2 inches from the finished surface. The remaining 2 inches shall then be patched according to the paragraph in Part 3 entitled "Treatment of Surface Defects."
   3. Small holes through all other concrete members shall be filled with nonshrink grout, with exposed faces treated as above.

B. Patching Large Holes
   1. Holes which are larger than 12 inches in their least dimension, shall have a keyway chipped into the edge of the opening all around, unless a formed keyway exists. The holes shall then be filled with concrete as specified herein.
   2. Holes which are larger than 24 inches in their least dimension and which do not have reinforcing steel extending from the existing concrete, shall have reinforcing steel set in drilled holes and epoxy grout as specified in Section 03 60 00 – Grouting. The reinforcing added shall match the reinforcing in the existing wall unless shown.
   3. Large holes in members which are water bearing or in contact with soil or other fill, shall have either a hydrophilic type or a plastic adhesive type waterstop material placed around the perimeter of the hole as specified herein, unless there is an existing waterstop in place.

3.7 CONCRETE FINISH

A. General: Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions shown are defined as tolerances and are specified herein. These tolerances are to be distinguished from irregularities in finish as described herein.

B. Aluminum finishing tools shall not be used.

C. Formed Surfaces:

1. Exterior buried surfaces require no treatment after form removal except for curing, repair of defective concrete, and treatment of surface defects.
2. Surfaces exposed to view shall be finished as specified under "Architectural Concrete Finish" below.

D. Surface holes larger than 1/2 inch in diameter or deeper than 1/4-inch are defined as surface defects in basins and exposed walls.

E. Unformed Surfaces: After proper and adequate vibration and tamping, all unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. Immediately after the concrete has been screeded, it shall be treated with a liquid evaporation retardant. The retardant shall be used again after each Work operation as necessary to prevent drying shrinkage cracks. The classes of finish specified for unformed concrete surfaces are designated and defined as follows:
1. Finish U1 – Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8 inch. No further special finish is required.
2. Finish U2 After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 1/4-inch. Joints and edges shall be tooled where shown or as determined by the Engineer.
3. Finish U3 After the floated surface (as specified for Finish U2) has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of all irregularities.
4. Finish U4 Steel trowel finish (as specified for Finish U3) without local depressions or high points. In addition, the surface shall be given a light broom finish with broom lines perpendicular to drainage unless otherwise shown. The resulting surface shall be rough enough to provide a nonskid finish.

F. Floor Hardener:
1. Apply to all exposed concrete floor surfaces.
2. Apply after concrete has cured minimum 7 days.
3. Apply in accordance with manufacturer's recommendations.
4. Keep floors covered and free of traffic and loads for a minimum of 10 days after completion.

3.8 ARCHITECTURAL CONCRETE FINISH

A. General: Architectural finish shall be required for permanently exposed concrete surfaces and in other locations where specifically called out on the Drawings.
1. Immediately after the forms have been stripped, the concrete surface shall be inspected and any poor joints, voids, rock pockets, or other defective areas shall be repaired and all form-tie holes filled as indicated herein.
2. Architectural finishes shall not be applied until the concrete surface has been repaired as required and the concrete has cured at least 14 days.

3. All architecturally treated concrete surfaces shall conform to the accepted sample required herein in texture, color, and quality. It shall be the Contractor's responsibility to maintain and protect the concrete finish.

B. Smooth Concrete Finish

1. The concrete surface shall be wetted, and a grout shall be applied with a brush. The grout shall be made by mixing one part Portland cement and one part of fine sand that will pass a No. 16 sieve with sufficient water to give it the consistency of thick paint. The cement used in said grout shall be 1/2 gray and 1/2 white Portland cement, as determined by the Engineer. The freshly applied grout shall be vigorously rubbed into the concrete surface with a wood float filling all small air holes. After all the surface grout had been removed with a steel trowel, the surface shall be allowed to dry and, when dry, shall be vigorously rubbed with burlap to remove completely all surface grout so that there is no visible paint-like film of grout on the concrete. The entire cleaning operation for any area shall be completed the day it is started, and no grout shall be left on the surface overnight.
2. Cleaning operations for any given day shall be terminated at panel joints. It is essential that the various operations be carefully timed to secure the desired effect which is a light-colored concrete surface of uniform color and texture without any appearance of a paint or grout film.
3. In the event that improper manipulation results in an inferior finish, rub such inferior areas with carborundum bricks.
4. Before beginning any of the final treatment on exposed surfaces, treat in a satisfactory manner a trial area of at least 200 square feet in some inconspicuous place selected by the Engineer and shall preserve said trial area undisturbed until the completion of the job.

3.9 WATERPROOFING

A. Apply waterproofing to exterior surface of all buried roof slabs and walls of underground concrete structures.

B. Refer to Section 07 14 00 – Fluid-Applied Waterproofing.

3.10 TOLERANCES:

A. Construction Tolerances: Set and maintain concrete forms and perform finishing operations so as to ensure that the completed Work is within the tolerances specified herein. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the specified permissible variation from lines, grades, or dimensions shown. Where tolerances are not stated in the Specifications, permissible deviations will be in accordance with ACI 117.

1. The following non-cumulative construction tolerances are hereby established and apply to finished walls and slab unless otherwise shown:

Item	Tolerance
Variation of the constructed linear outline from the established position in plan.	In 10 feet: 1/4 inch In 20 feet or more: 1/2 inch

Item	Tolerance
Variation from the level or from the grades shown.	In 10 feet: 1/4 inch In 20 feet or more: 1/2 inch
Variation from plumb.	In 10 feet: 1/4 inch In 20 feet or more: 1/2 inch
Variation in the thickness of slabs and walls.	Minus 1/4 inch Plus 1/2 inch
Variation in the locations and sizes of slabs and wall openings.	Plus or minus 1/4 inch

3.11 FIELD QUALITY CONTROL

A. General
1. Tests on component materials and for slump, temperature, air content, compressive strength and shrinkage of concrete will be performed as specified herein.
2. The cost of all laboratory tests for qualification of mix designs on cement, aggregates, and concrete, including strength and shrinkage testing will be borne by Contractor. The cost of all field testing during construction, including slump, temperature, air, strength and shrinkage will also be borne by Owner. However, Contractor will be charged for the cost of any additional tests and investigation on work performed which does not meet the Specifications.
3. Provide access for Engineer to aggregate stockpiles for concurrent sampling during construction.
4. Provide access for Engineer to batch plant for monitoring batching procedures during construction.
5. Concrete for testing shall be supplied by Contractor at no additional cost to Owner, and Contractor shall provide assistance to Engineer in obtaining samples, and disposal and cleanup of excess material.
6. Composite samples of concrete placed in the Work shall be taken in accordance with ASTM C172 from the first placement of each class of concrete and at the following minimum frequency for each class:
    a. Not less than one sample per day on which concrete it placed.
    b. Not less than one sample for each 100 cubic yards of concrete placed.
    c. Not less than one sample for each 5,000 square feet of surface area for slabs or walls.
    d. Not less than 5 samples from randomly selected batches for the Work.

B. Slump Tests
1. Perform in accordance with requirements of ASTM C143 at frequency indicated for sampling above.

C. Temperature Tests
1. Test concrete temperature per ASTM C1064 at frequency indicated for sampling above.

D. Air Content Tests
1. Test air content per ASTM C231 at frequency indicated for sampling above.

E. Shrinkage Tests

1. Drying shrinkage tests will be made for the first placement of each class of structural concrete, and during construction every 3 months to insure continued compliance with these Specifications. A minimum of 1 test per structure shall be made regardless of the timing.
2. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gage length of 10 inches, fabricated, cured, dried and measured in accordance with ASTM C157.
3. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage test value by more than 25 percent.
    a. If the required shrinkage limitation is not met during construction, take any or all of the following actions, at no additional cost to the Owner, for securing the specified shrinkage requirements. These actions may include changing the source or aggregates, cement and/or admixtures; reducing water content; washing of aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

F. Field Compression Tests
1. Field compression test specimens will be made at the frequency indicated for sampling above.
2. Each set of test specimens will be a minimum of five cylinders.
3. Compression test specimens for concrete shall be made in accordance with ASTM C31. Specimens shall be 6-inch diameter by 12-inch high cylinders.
4. Compression tests shall be performed in accordance with ASTM C 39. One test cylinder will be tested at 7 days and two at 28 days. The remaining cylinders will be held to verify test results, if needed.

G. Evaluation and Acceptance of Concrete
1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 350 and as specified herein.
2. A statistical analysis of compression test results will be performed according to the requirements of ACI 214. The standard deviation of the test results shall not exceed 640 psi, when ordered at equivalent water content as estimated by slump.
3. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for all subsequent batches of the type of concrete affected.
4. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 psi below or the average of any three consecutive tests being below the specified compressive strength is 1 in 100. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard of deviation.
5. All concrete which fails to meet the ACI requirements and these Specifications, is subject to removal and replacement at no increase in cost to the Owner.

3.12 APPLICATION OF LOADS

A. Do not allow traffic, construction equipment, or materials of any kind to be placed on elevated concrete slabs until the concrete has attained a minimum age of 7 days and 80% of the minimum specified 28-day strength as proven by concrete strength tests.

B. Do not place backfill against cantilevered walls until the concrete has attained a minimum age of 7 days and 100% of the minimum specified 28-day concrete strength as proven by concrete strength tests.

C. Do not place backfill against walls that are tied to elevated slabs or decks until the both the slabs and walls have attained a minimum age of 7 days and 80% of the minimum specified 28-day strength as proven by concrete strength tests.

3.13 SCHEDULES

A. Grout: As specified in Section 03 60 00 – Grouting.

B. Unformed Concrete Surfaces: Apply finish as follows.

Area	Finish
Grade slabs and foundations to be covered with concrete or fill material	U1
Floors to be covered with grouted tile or topping grout	U2
Slabs not water bearing	U4
Slabs to be covered with built-up roofing	U2
Interior slabs and finished floors, without architectural finishes	U4
Interior slabs and finished floors with architectural finishes	U3
Top surface of walls	U3

END OF SECTION

SECTION 03 35 43
POLISHED CONCRETE FINISHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes polished concrete finishing, including staining.
   1. Concrete for polished concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, initial finishing, and curing is specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Related Requirements:
   1. Section 03 30 00 "Cast-in-Place Concrete" for concrete not designated as polished concrete.

1.3 DEFINITIONS

A. Design Reference Sample: Sample designated by Architect in the Contract Documents that reflects acceptable surface quality and appearance of polished concrete.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with polished concrete to attend, including the following:
      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixtures.
      c. Ready-mix concrete manufacturer.
      d. Cast-in-place concrete subcontractor.
      e. Polished concrete finishing Subcontractor.
   2. Review cold- and hot-weather concreting procedures, curing procedures, construction joints, concrete repair procedures, concrete finishing, and protection of polished concrete.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Polishing Schedule: Submit plan showing polished concrete surfaces and schedule of polishing operations for each area of polished concrete before start of polishing operations. Include locations of all joints, including construction joints.

C. Samples for Initial Selection: For each type of product requiring color selection.

D. Samples for Verification: For each type of exposed color.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material Certificates: For each of the following, signed by manufacturers:
1. Repair materials.
2. Stain materials.
3. Liquid floor treatments.

1.7 QUALITY ASSURANCE

A. Field Sample Panels: After approval of verification sample and before casting concrete, produce field sample panels to demonstrate the approved range of selections made under Sample submittals. Produce a minimum of three sets of full-scale panels, approximately 48 by 48 inches (1200 by 1200 mm) minimum, to demonstrate the expected range of finish, color, and appearance variations.
1. Locate panels as indicated or, if not indicated, as directed by Architect.
2. Maintain field sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
3. Demolish and remove field sample panels when directed.

B. Mockups: Before casting concrete, build mockups to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
2. Demonstrate curing, finishing, and protecting of polished concrete.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Manufacturer Qualifications: Minimum 10 years of documented experience producing the specified products.

D. Installer Qualifications: Minimum 5 years of documented experience with work of similar scope and complexity required by this Project and acceptable to, or certified by, concrete stain manufacturer.

1.8 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 STAIN MATERIALS

A. Penetrating Stain: Water-based, acrylic latex, penetrating stain with colorfast pigments.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. H&C® Decorative Concrete Products; a brand of Sherwin-Williams Co.
      b. NewLook International, Inc.
      c. Scofield, L. M. Company.

2.2 STAIN COLOR

A. Provide a mixture of 2-3 stain colors.

2.3 FINISH SEALER

A. Provide one of the following sealers:
   1. Acrylic-Polyurethane Sealer: One-component clear acrylic-polyurethane sealer. Low VOC formulation. VOC content less than 100 g/L.
      a. Basis of Design Product: Scofield's "SCOFIELD Selectseal-W."
   2. Waterborne Sealer: Low VOC waterborne modified acrylic formulation. Complies with ASTM C 309. VOC content less than 100 g/L.
      a. Product: Scofield's "SCOFIELD Cureseal-W."

PART 3 - EXECUTION

3.1 POLISHING

A. Polish: Level 3: High sheen, 800 grit.

B. Apply polished concrete finish system to cured and prepared slabs to match accepted mockup.
   1. Machine grind floor surfaces to receive polished finishes level and smooth.
   2. Apply reactive stain for polished concrete in polishing sequence and according to manufacturer's written instructions.
   3. Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
   4. Apply penetrating stain for polished concrete in polishing sequence and according to manufacturer's written instructions.
   5. Continue polishing with progressively finer-grit diamond polishing pads to gloss level, to match approved mockup.
   6. Control and dispose of waste products produced by grinding and polishing operations.
   7. Neutralize and clean polished floor surfaces.

3.2 STAINING

A. Newly placed concrete shall be at least 14 days old before staining.

B. Prepare surfaces according to manufacturer's written instructions and as follows:
   1. Clean concrete thoroughly by scraping, applying solvents or stripping agents, sweeping and pressure washing, or scrubbing with a rotary floor machine and detergents recommended by stain manufacturer. Rinse until water is clear and allow surface to dry.
      a. Do not use acidic solutions to clean surfaces.
   2. Test surfaces with droplets of water. If water beads and does not penetrate surface, or penetrates only in some areas, profile surfaces by grinding, sanding, or abrasive blasting. Retest and continue profiling surface until water droplets immediately darken and uniformly penetrate concrete surfaces.
   3. Apply acidic solution to dampened concrete surfaces, scrubbing with uncolored, acid-resistant nylon-bristle brushes until bubbling stops and concrete surface has texture of 120-grit sandpaper. Do not allow solution to dry on concrete surfaces. Rinse until water is clear. Control, collect, and legally dispose of runoff.
   4. Neutralize concrete surfaces and rinse until water is clear. Test surface for residue with clean white cloth. Test surface according to ASTM F 710 to ensure pH is between 7 & 8.

C. Allow concrete surface to dry before applying stain. Verify readiness of concrete to receive stain according to ASTM D 4263 by tightly taping 18-by-18-inch (450-by-450-mm), 4-mil-(0.1-mm-) thick polyethylene sheet to a representative area of concrete surface. Apply stain only if no evidence of moisture has accumulated under sheet after 16 hours.

D. Penetrating Stain: Apply penetrating stain to concrete surfaces according to manufacturer's written instructions and as follows:
   1. Apply first coat of stain to dry, clean surfaces by airless sprayer or by high-volume, low-pressure sprayer.
   2. Allow to dry four hours and repeat application of stain in sufficient quantity to obtain color consistent with approved mockup.
   3. Rinse until water is clear. Control, collect, and legally dispose of runoff.

END OF SECTION

SECTION 03 60 00
GROUTING

PART 1 - GENERAL

1.1 SUMMARY

A. Work includes various types of cementitious grout to be provided and installed per the Contract Documents

B. Section includes the following types of grout:
1. Cement grout.
2. Nonshrink grout.
3. Epoxy grout.
4. Grout for repair of concrete.
5. Pump and motor grout.
6. Concrete topping gout and concrete fill.

1.2 REFERENCES

A. American Concrete Institute (ACI) standards, most recent editions:

ACI 318	Building Code Requirements for Reinforced Concrete
ACI 308	Standard Practice for Curing Concrete

B. American Society for Testing and Materials (ASTM) standards, most recent editions:

ASTM C78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C94	Standard Specifications for Ready-Mixed Concrete
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
ASTM C307	Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
ASTM C348	Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars
ASTM C469	Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
ASTM C531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.

ASTM C579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
ASTM C827	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear
ASTM C884	Standard Test Method for Thermal Compatibility Between Concrete and an Epoxy-Resin Overlay
ASTM C939	Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C1090	Standard Test Method for Measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout
ASTM C1107	Packaged Dry, Hydraulic Cement Grout (Nonshrink)
ASTM C1181	Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts
ASTM C1202	Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C1339	Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D696	Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C With a Vitreous Silica Dilatometer
ASTM E329	Standard Specification for Agencies Engaged in Construction Inspection and/or Testing

C. International Concrete Repair Institute (ICRI) standards, latest editions:

Guideline No 310.1R	Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
Guideline No 320.2R	Guide for selecting and specifying Materials for repair of Concrete Surfaces

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Product Data:
   1. Submit certified test results verifying the compressive strength, shrinkage, and expansion requirements indicated herein.
   2. Submit manufacturer's literature containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of nonshrink and epoxy grout used in the Work.

C. Certification:
   1. Provide manufacturer’s independent certification of compliance with ASTM C1107 without modification to the standard methods certifying that the Class B or C grout's post-hardening non-shrink properties are not based on gas expansion.
   2. Provide Manufacturer's certification that grouts have strengths of 3500 psi at 1 day, 6500 psi at 3 days and 7500 psi at 28 days when cured at 72 degrees F as well as meeting the 3, 7, and 28-day strengths when tested and cured at the 45 degree F and 95 degree F limits and all other requirements of ASTM C1107.
   3. The Contractor shall engage an independent testing laboratory to run a 24-hour grout evaluation in accordance with ASTM C1107 of each grout submitted for approval showing compliance with all aspects of the evaluation. Submit results to the Engineer for review.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Maintain all materials clean, dry and protected against dampness, freezing and foreign matter.
   1. Store non-shrink grout materials in temperature controlled environments above 40 degrees F and below 90 degrees F.
   2. Store epoxy grout components in temperature controlled environments above 60 degrees F and below 90 degrees F.

C. Deliver epoxy resin, hardener, and aggregate in sealed pre-measured containers, palletized and shrink-wrapped to prevent shipping damage.

D. Immediately remove from the Project site any cement-based grout material which becomes damp or otherwise defective.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Nonshrink, nonmetallic grout:
      a. 5 Star Grout, Five Star Products, Inc.

b. Masterflow 928, BASF Building Systems, Inc.
c. NS Grout, Euclid Chemical Company.
d. Sika Grout 212, Sika Corporation.
e. Engineer approved equal.

2. Epoxy grout:
a. HP Epoxy Grout, Five Star Products, Inc.
b. Masterflow 648 CP Plus, BASF Building Systems, Inc.
c. E³-Flowable, Euclid Chemical Company.
d. Sikadur 42 Grout-Pak, Sika Corporation.
e. Engineer approved equal.

3. Grout for pumps and motors:
a. Escoweld, ITW Polymer Technologies.
b. Chockfast Red, ITW Polymer Technologies.
c. DP Epoxy Grout, Five Star Products, Inc.
d. Engineer approved equal.

2.2 CEMENT GROUT

A. Cement grout shall be composed of one-part cement, three parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white Portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 days shall be 4,500 psi.

B. Cement grout materials shall be as specified in Section 03300 – Cast-in-Place Concrete.

2.3 NONSHRINK GROUT

A. Non-shrink grout shall be a prepackaged, inorganic, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water.

B. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.

C. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout herein shall be that recommended by the manufacturer for the particular application. All grouts (Grade B or C) shall be tested for height change of the hardened grout at 1, 3, 14, and 28 days in accordance with ASTM C1090 and shall be tested for compression at 1, 3, 7, and 28 days in accordance with the modified ASTM C109 testing procedure.

D. Class A non-shrink grouts: Not used.

E. Class B or C high precision, fluid, extended working time, non-shrink grouts:
1. Minimum 28-day compressive strength of 7500 PSI.
2. No shrinkage (0.0 percent) and a maximum of 4.0 percent expansion in the plastic state when tested in accordance with ASTM C827.
3. No shrinkage (0.0 percent) and a maximum of 0.2 percent expansion in the hardened state
4. When mixed to a fluid consistency of 20 to 30 seconds per ASTM C939 at temperature extremes of 45 to 90 degrees F shall have an extended working time of 30 minutes when tested in accordance with ASTM C1107.

F. Application:

1. Class B or C non-shrink grout shall be used for grouting under all base plates for structural steel members, grouting under all equipment base plates except for pumps and motors, and at all locations where grout is required by the Contract Documents except where epoxy grout or grout for pumps and motors is specifically required. Class B or C non-shrink grout shall be used in place of Class A non-shrink grout for all applications. Class B or C non-shrink grout shall not be used for dry packing applications or repair of concrete.

2.4 EPOXY GROUT

A. Epoxy grout shall be a pourable, nonshrink, 100 percent solids system. The epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all premeasured and prepackaged. The resin component shall not contain any nonreactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application.

B. The mixed epoxy grout system shall have a minimum working life of 45 minutes at 75 degrees F.

C. The epoxy grout shall develop a compressive strength of 5,000 psi in 24 hours and 10,000 psi in 7 days when tested in accordance with ASTM C579, Method B. There shall be no shrinkage (0.0 percent) and a maximum 4.0 percent expansion when tested in accordance with ASTM C827.

D. The epoxy grout shall exhibit a minimum effective bearing area of 95 percent. This shall be determined by testing in accordance with ASTM C1339, for bearing area and flow.

E. The peak exotherm of a 2-inch diameter by 4-inch high cylinder shall not exceed 95 degrees F when tested with 75 degree F material at laboratory temperature. The epoxy grout shall exhibit a maximum thermal coefficient of 30 x 10-6 inches/inch/degree F when tested according to ASTM C531 or ASTM D696.

F. Application:

1. Epoxy grout shall be used to embed all anchor bolts and reinforcing steel required to be set in grout and for all other applications in the Contract Documents where grout type is not specifically indicated.

2.5 GROUT FOR REPAIR OF CONCRETE

A. Vertical, overhead, and shotcrete applications:

1. Shall not produce a vapor barrier.
2. One component, reoplastic, cement based, shrinkage compensated, non-expansive, gray concrete product.
3. Sprayable, extremely low permeability, sulfate resistant, easy to use and requiring only the addition of water.

4. Free of chlorides and other chemicals causing corrosion with the following properties:
    a. Minimum Slant Shear Bond Strength: 2500 PSI at 28 days when tested in accordance with ASTM C882.
    b. Minimum Compressive strength: 6,500 PSI at 28 days when tested in accordance with ASTM C109.
    c. Minimum Tensile Bond Strength: 200 PSI at 28 days per ASTM C307.
    d. Minimum Flexural Strength: 1,200 PSI when tested in accordance with ASTM C348.
    e. Modulus of Elasticity: 3.6E6 PSI when tested in accordance with ASTM C469.
    f. Maximum Rapid Chloride Permeability: 772 coulombs when tested in accordance with ASTM C1202.

B. Horizontal and formed applications:
1. Shall not produce a vapor barrier.
2. One component, reoplastic, cement-based, shrinkage compensated, non-expansive, gray concrete product.
3. Flowable, extremely low permeability, sulfate resistant, easy to use and requiring only the addition of water.
4. Free of chlorides and other chemicals causing corrosion with the following properties:
    a. Minimum Shear Bond Strength: 2150 PSI at 7 days.
    b. Minimum Compressive Strength: 6000 PSI at 7 days when tested in accordance with ASTM C109.
    c. Minimum Flexural Strength: 770 PSI at 28 days when tested in accordance with ASTM C78.
    d. Maximum Chloride Permeability: 1,000 coulombs when tested in accordance with ASTM C1202.
    e. Modulus of Elasticity: 4.8E6 PSI when tested in accordance with ASTM C469.

2.6 GROUT FOR PUMPS AND MOTORS

A. Grout for pumps and motors shall be epoxy grouts meeting the following minimum requirements:
1. Creep shall be less than 0.005 in/in when tested by ASTM C1181 method. The test shall be at 70 degrees F and 140 degrees F with a load of 400 PSI.
2. Linear shrinkage shall be less than 0.080 percent and thermal expansion less than 17E-6 in/in/degree F when tested by ASTM C531.
3. The compressive strength shall be a minimum of 12,000 PSI in 7 days when tested by ASTM C579 Method B, modified.
4. Bond strength of grout to Portland cement concrete shall be greater than 2,000 PSI when using ASTM C882 test method.
5. Grout shall pass the thermal compatibility test when overlaid on Portland cement concrete using test method ASTM C884.
6. Tensile strength and modulus of elasticity shall be determined by ASTM D638. The tensile strength shall not be less than 1,700 PSI and the modulus of elasticity shall not be less than 1.8E6 PSI.
7. Peak exothermic temperature shall not exceed 110 degrees F when a specimen 6 inches in diameter by 12 inches high is used. Gel time shall be at least 150 minutes.

8. The grout shall be suitable for supporting precision machinery subject to high impact and shock loading in industrial environments while exposed to elevated temperatures as high as 150 degrees F, with a load of 2,000 PSI.

B. Primer, if required, shall conform to the written recommendations of the grout manufacturer.

C. Surface preparations shall conform to the written recommendations of the grout manufacturer.

D. Placement and Curing
1. Placement and curing procedures shall be in accordance with the written recommendations of the grout manufacturer.
2. A grouting performance demonstration/training session shall be conducted by the grout manufacturer's representative prior to foundation and baseplate preparation and the first grouting on site. This training session shall demonstrate proper preparation and installation methods and that the grouting material meets the strength requirements.

2.7 CONCRETE TOPPING GROUT AND CONCRETE FILL

A. Grout for topping of slabs and concrete fill for built up surfaces of tank, channel, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures as necessary, with strength as specified above.

B. Where concrete topping is deeper than 6 inches, it will be considered "Concrete Fill" and may be placed using either grout as specified herein or "lean concrete", as specified in Section 03300 – Cast-In-Place Concrete, when approved by Engineer.

2.8 CURING MATERIALS

A. Curing materials shall be as specified in Section 03300 – Cast-In-Place Concrete for cement grout and as recommended by the grout manufacturer for prepackaged grouts.

2.9 CONSISTENCY

A. Use grouts with the consistency necessary to completely fill space to be grouted for the particular application. Where "dry pack" is called for in the Contract Documents, use grout with a consistency such that the grout is plastic and moldable but will not flow.

B. Regardless of consistency called for on the Contract Documents, the type of grout to be used shall be as indicated herein for the particular application.

2.10 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement will not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the grout manufacturer.

PART 3 - EXECUTION

3.1 PERPARATION

A. All surface preparation, curing, and protection of cement grout shall be as indicated in Section 03300 – Cast-In-Place Concrete. The finish of the grout surface shall match that of the adjacent concrete.

B. Do not place grout on concrete or masonry substrates until those substrate materials have attained 28-day design strength unless authorized by Engineer.

3.2 MANUFACTURER'S SERVICES

A. The manufacturer of nonshrink grout and epoxy grout shall provide onsite technical assistance upon request.

B. Coordinate with the manufacturer all demonstrations, training sessions, and applicable site visits. The grout manufacturer shall conduct onsite, demonstration and training sessions for bleed tests, mixing, flow cone measurements, cube testing, application, and curing for each category and type of grout.

C. Training by the manufacturer is required for all types of grout installations. Grout manufacturer's representative shall train Contractor to perform the grout Work including mixing of grouts to required consistency, testing, placing, and curing on actual project base plates, tie holes, rock pockets, and other applications.

3.3 GROUTING PROCEDURES

A. Prepackage Grouts: All mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

B. Base Plate Grouting:
   1. For base plates, the original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a 1 inch thickness of grout or a thickness as indicated on the Contract Drawings.
   2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout. The mixture shall be of a trowelable consistency and tamped or rodded solidly into the space between the plate and the base concrete. A backing board or stop shall be provided at the back side of the space to be filled with grout. Where this method of placement is not practical or where required by Engineer, alternate grouting methods shall be submitted for acceptance by Engineer.

C. Concrete Topping Grout:
   1. All mechanical, electrical, and finish Work shall be completed prior to placement of concrete topping or concrete fill. The base slab shall be given a roughened textured surface by sandblasting or hydroblasting exposing the aggregates to ensure bonding to the base slab.

2. The minimum thickness of grout topping and concrete fill shall be one inch. Where the finished surface of concrete fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 6-inches wide by 1-1/2 inches deep.
3. The base slab shall be thoroughly cleaned and wetted prior to placing topping and fill. No topping concrete shall be placed until the slab is complete free from standing pools or ponds of water. A thin coat of neat Type II cement grout shall be broomed into the surface of the slab just before topping of fill placement. The topping and fill shall be compacted by rolling or tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade.
4. Concrete topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.
5. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping and fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement or mixture of dry cement and sand shall be applied to the surface.

D. Grout for Repair of Concrete
1. All repairs shall be performed in accordance with the manufacturer's recommendations and with ICRI Guideline No 310.1R and Guideline No 320.2R. These guidelines shall be followed for removal geometry, exposing and undercutting of reinforcing steel, cleaning and repair of reinforcing steel, and edge and surface condition of concrete and shall be followed regardless of the amount of corrosion present or not present in the reinforcing steel.
2. Remove unsound deteriorated concrete from Work by high pressure water blasting machines capable of scoring concrete surfaces to minimum amplitude roughness of 3/16-inch. Remove to provide for minimum thickness specified for mortar. If reinforcing is exposed in this process, then additional concrete shall be removed until the surface is a minimum of 1-inch or 1 bar diameter behind the exposed reinforcing.
3. Clean exposed reinforcing bars of rust and other deleterious materials which may prevent bonding of the repair product.
4. Keep surface at saturated surface dry (SSD) condition for a minimum of 24-hours prior to placement of repair material.
5. Place material in accordance with Manufacturer's written recommendations.
6. Cure material continuously for 7-days with water fog nozzles or other applications which provide a continuous wet curing of the repaired area in accordance with ACI 308.

E. CONSOLIDATION
1. Grout shall be placed in such a manner, for the consistency necessary for each application, so as to assure that the space to be grouted is completely filled.

END OF SECTION

DIVISION 04
MASONRY

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SECTION 04 01 20
MASONRY CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Work includes cleaning exposed masonry surfaces.

1.2 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Provide a letter stating that Contractor has a minimum of 5 years' experience in this type of masonry cleaning.

C. Product Data:

1. Manufacturer's instructions, including application rates.
2. Manufacturer's recommendations for neutralizing rinse after cleaning.

D. Samples for Verification:

1. Prior to erecting mock-up, procure and clean two samples of each type of masonry used in Work. Cleaned samples shall be submitted to Engineer for review of aesthetics and effectiveness.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Engaged in producing masonry cleaners that have been used for similar applications with successful results for a minimum or five years, and with factory-trained representatives who are available for consultation and site inspection and assistance at no additional cost to the Owner.
2. Applicator: Trained, approved, and accepted by the cleaning compound manufacturer. Application personnel shall have at least two years of experience with the particular materials being applied.

B. Mock-ups:

1. Clean an area approximately 10 to 20 square feet or larger as required to demonstrate effectiveness of cleaner on each type of masonry unit used. Upon approval of Engineer, cleaner may be applied to mock-up panels constructed in Section 04 22 00 Concrete Unit Masonry Hi-R.
    a. Prepare mock-ups on existing walls under same weather conditions to be expected during remainder of Work.

b. Test cleaners and methods on samples of adjacent non-masonry materials for possible adverse reactions. Samples of tested materials shall be available for Engineer's review upon request.
c. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of sample panels for negative reactions.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Deliver materials in manufacturer's original, unopened containers, labeled with manufacturer's name, batch number, and type of materials

C. Store materials in original, unopened containers in compliance with manufacturer's printed instructions.

D. Do not store in areas where temperature will fall below 20 degrees F or rise above 100 degrees F.

1.5 PROJECT CONDITIONS

A. Schedule application of products such that temperature and humidity levels conform to manufacturer's requirements during and after application.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Cleaning solution: Detergent type.
   a. Diedrich Technologies, Inc.; "202 New Masonry Detergent."
   b. Elgene; "Florok 700 Masonry Detergent."
   c. PROSOCO, Inc.; "Sure Klean #600 Detergent."
   d. Engineer approved equal.
2. Cleaning solution for manganese and vanadium stained masonry:
   a. Diedrich Technologies, Inc.; "202V Vana-Stop Mew Masonry."
   b. Elgene "960 Masonry Cleaner."
   c. PROSOCO "Ferrous Stain Remover."
   d. Engineer approved equal.

2.2 MATERIALS

A. Water for Cleaning: Potable

B. Detergent Type Cleaning Solution:
1. Manufacturer's standard-strength cleaner designed for removing mortar and grout stains, efflorescence, and other new construction stains from new masonry without

discoloring or damaging masonry surfaces. Use products expressly approved for intended use by cleaning solution manufacturer and manufacturer of masonry units being cleaned.

2. Cleaner shall be a solution of blended liquid acids, heavily inhibited and emulsified and in combination with special wetting systems.
3. Specific product selection shall be dependent upon substrate as recommended by the cleaning solution manufacturer.
4. Muratic acid will not be acceptable as a cleaning solution for new masonry.

C. Cleaning Solution for Manganese or Vanadium Stained Masonry:

1. Manufacturer's standard-strength cleaner designed for removing vanadium, manganese, and other metallic stains without discoloring or damaging masonry surfaces. Use products expressly approved for intended use by cleaning solution manufacturer and manufacturer of masonry units being cleaned.
2. Cleaner shall be a solution of blended liquid acids, heavily inhibited and emulsified and in combination with special wetting systems.
3. Specific product selection shall be dependent upon substrate as recommended by the cleaning solution manufacturer.
4. Muratic acid will not be acceptable as a cleaning solution for new masonry.

D. Neutralizing rinse: Rinse to be as required by the manufacturer of the cleaners used.

PART 3 - EXECUTION

3.1 PREPARATION

A. Allow 7 to 28 days after completion of masonry work before start of cleaning.

B. Protection:

1. Protect surrounding surfaces and installed Work from run-off, overspray, and splashing. Erect temporary protective covers and walkways at points of pedestrian and vehicular entrance and exit that must remain in service during course of cleaning.
2. Comply with cleaning solution manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent cleaning solutions from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.
    a. Cover adjacent surfaces with materials that are proven to resist the cleaning solutions used. Use materials that contain only waterproof, UV-resistant adhesives. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. Promptly remove masking after cleaner application to prevent adhesive staining.
    b. Keep wall wet below area being cleaned to prevent streaking from runoff.
    c. Do not clean masonry during winds of sufficient force to spread cleaning solutions to unprotected surfaces.
    d. Dispose of runoff from cleaning operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

C. Surface Preparation:
1. Prepare surfaces in strict accordance with manufacturer's printed instructions.
2. Remove excess mortar using wooden paddles and scrapers. Do not scratch or chip masonry surface.
3. Point up cracks, other than hairline cracks
4. Defective mortar joints shall be routed out, pointed with mortar, and tooled.
5. Before beginning general cleaning, remove extraneous substances that are resistant to cleaning methods being used. Extraneous substances include paint, calking, asphalt, and tar.
6. Remove paint and calking with approved alkaline or solvent paint remover.
   a. Comply with requirements for paint removal
   b. Repeat application up to two times if needed.
7. Remove asphalt and tar with approved asphalt and tar remover solution.
   a. Apply only to asphalt and tar by brush without prewetting.
   b. Allow asphalt and tar remover to remain on surface for 10 to 30 minutes.
   c. Rinse off with water using low pressure spray.
   d. Repeat application if needed.

3.2 CLEANER APPLICATION

A. Apply cleaner in strict accordance with manufacturer's printed instructions.
1. Do not use wire brushes or brushes that are not resistant to cleaning solution being used.
2. Use spray equipment that provides controlled application at volume and pressure recommended by manufacturer, measured at spray tip. Adjust pressure and volume to ensure that cleaning methods do not damage masonry.
3. Cleaning solution application:
   a. In accordance with manufacturer's instructions, apply cleaning solution to masonry surfaces using brush or spray application methods, at Contractor's option.
   b. Use low-pressure tank or chemical pump suitable for cleaner indicated, equipped with cone-shaped spray tip.
   c. Do not spray apply at pressures exceeding 50 psi.
   d. Do not allow solution to remain on surface for periods longer than those indicated or recommended by manufacturer.
   e. Reapply cleaner as recommended by manufacturer prior to removing excess mortar.
4. Water application:
   a. Water soak application:
      1) Soak masonry surfaces by applying water continuously and uniformly to limited area for time indicated. Apply water at low pressures and low volumes in multiple fine sprays using perforated hoses or multiple spray nozzles.
      2) Erect a protective enclosure constructed of polyethylene sheeting to cover area being sprayed.
   b. Spray Applications:
      1) Use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.

2) Unless otherwise indicated, hold spray nozzle at least six inches from surface of masonry and apply water in horizontal back and forth weeping motion, overlapping previous strokes to produce uniform coverage.

5. High-pressure water spray application:
   a. Use fan-shaped spray tip that disperses water at an angle of at least 40 degrees.

B. Perform cleaning method indicated in a manner that results in uniform coverage for all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces.

C. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that cleaning solution is completely removed. Apply neutralizing agent and repeat rinse, if necessary, to produce tested pH of between 6.7 and 7.5.

D. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

3.3 FINAL CLEANING

A. Wash adjacent woodwork and other nonmasonry surfaces. Use detergent and soft brushes or cloths.

B. Clean mortar and debris from roof. Remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

C. Sweep and rake adjacent pavement and grounds to remove mortar and debris. Where necessary, pressure wash surfaces to remove mortar, dust, dirt, and stains.

END OF SECTION

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SECTION 04 05 12
MORTAR AND GROUT

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install mortar and grout for masonry construction in accordance with Contract Documents.

1.2 RELATED SECTIONS

A. Section 04 22 00 – Concrete Unit Masonry

1.3 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM C5	Standard Specification for Quicklime for Structural Purposes
ASTM C109	Compressive Strength of Hydraulic Cement Mortars
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C207	Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C270	Standard Specification for Mortar for Unit Masonry
ASTM C404	Standard Specification for Aggregates for Masonry Grout
ASTM C476	Standard Specification for Grout for Masonry
ASTM C1019	Standard Test Method for Sampling and Testing Grout
ASTM E514	Standard Test Method for Water Penetration and Leakage Through Masonry

1.4 DEFINITIONS

A. Coarse grout and fine grout are defined by the aggregate size used in accordance with ASTM C476.

B. Coarse aggregate and fine aggregate are defined in ASTM C404, Table 1.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Submit proposed grout mix design including aggregate data to show conformance to these specifications, including cement data to show conformance to these specifications and ASTM C150. Submit the proposed method of placing grout.

C. Submit proposed mortar mix design including aggregate data to show conformance to these specifications, including cement data to show conformance to these specifications and ASTM C150.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Maintain all materials clean, dry and protected against dampness, freezing and foreign matter.

C. Store sand only on smooth, well-drained ground free from dust, mud and debris.

D. Do not use bottom 6 inches of pile in mortar.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Integral mortar water repellent:
      a. ACM Chemistries, Inc.: RainBloc.
      b. BASF/Master Builders; MasterPel 240MA.
      c. Grace Construction Products; Dry Block.
      d. Krete Industries, Inc.; Gard Mortar Mix.
      e. Engineer approved equal.
   2. Admixtures for grout
      a. BASF/Master Builders; Pozzolith.
      b. Sika Corporation; SikaGrout Aid Type II.
      c. Engineer approved equal.

2.2 MATERIALS

A. Portland Cement: ASTM C150, Type II, natural color.

B. Mortar Aggregate: ASTM C144, standard masonry type.

C. Hydrated Lime: ASTM C207, Type S.

D. Quicklime: ASTM C5, non-hydraulic type.

E. Grout Aggregate: ASTM C404.

F. Mixing Water: Potable.

G. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units that also contain integral water repellent by same manufacturer.

H. Admixtures for Mortar:
   1. Admixtures may be used to obtain the desired or required workability and may be used instead of lime.
   2. The admixture shall not be detrimental to bonding characteristics nor increase the efflorescence.

I. Admixtures for Grout:
   1. Admixtures for grout may be used only when approved by Engineer. If used, they shall be used in accordance with the manufacturer's published recommendations and included in the proposed grout mix submittal.

J. Color: When colored masonry is specified, mortar for use with colored masonry units shall have integral color as approved by Engineer. Color shall match block color.

2.3 MORTAR MIXES

A. ASTM C270, Type M or S mortar mix shall be used. Use the Property Method.

B. Whenever a fire-resistance classification or rating is shown for unit masonry construction, provide mortar of type which has been tested and listed by UL for construction indicated.

C. Thoroughly mix mortar ingredients in quantities needed for immediate use in accordance with ASTM C270.

D. Mix materials a minimum of 3 minutes.

E. Do not use masonry cement.

F. Do not use anti-freeze compounds to lower the freezing point of mortar.

G. Provide water repellant treated mortar per water repellant manufacturer's recommended rate. When tested as a wall assembly made with CMU containing integral water repellent manufacturer’s block additive according to ASTM E514, with test period extended to 24 hours, show no visible water or leaks on the back of the test specimen.

2.4 GROUT MIXES

A. Thoroughly mix mortar ingredients in quantities needed for immediate use in accordance with ASTM C476.

B. Grout strength: For regular masonry units, 2000 psi strength at 28 days and for Hi-R masonry units, 2000 psi strength at 28 days when tested in accordance with ASTM C1019, 8-10 inches slump.

C. Do not use anti-freeze compounds to lower the freezing point of grout.

D. Mix materials a minimum of 5 minutes.

2.5 SOURCE QUALITY CONTROL

A. Perform laboratory test on mortar and grout in accordance with ASTM C109 using the same mix design as proposed for the Work.

PART 3 - EXECUTION

3.1 PREPARATION

A. Plug cleanout holes with block masonry units to prevent leakage of grout materials. Brace masonry for wet grout pressure.

3.2 INSTALLATION

A. Install mortar and grout per requirements of Section 04 22 00 – Concrete Unit Masonry.

B. Use coarse grout in spaces with least dimension over 2 inches.

C. Use fine grout for grouting door and window frames in masonry.

D. Remove excess mortar from grout spaces.

E. Work grout into masonry cores and cavities to eliminate voids.

F. Do not displace reinforcement while placing grout.

3.3 FIELD QUALITY CONTROL

A. Field quality control for masonry mortar and grout will be performed in conjunction with masonry prism testing specified in Section 04 22 00 – Concrete Unit Masonry. Separate tests for grout and mortar will not be required.

B. If Mortar begins to stiffen within 2½ hours, it may be retempered by adding water and remixing

C. Do not use mortar after it has begun to set. No mortar shall be used beyond 2½ hours after initial mixing.

D. Use grout within 2 hours after initial mixing. Use no grout after it has begun to set.

END OF SECTION

SECTION 04 22 00
CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install concrete masonry in accordance with Contract Documents.

B. Work shall include installation of ties, spacers, supports and other appurtenances necessary to meet Specifications and produce finished masonry structures.

1.2 RELATED SECTIONS

A. Section 03 20 00 – Concrete Reinforcing.

B. Section 04 05 12 – Mortar and Grout.

C. Section 04 01 20 – Masonry Cleaning.

D. Section 07 92 00 – Joint Sealants.

1.3 REFERENCES

A. American Concrete Institute (ACI) standards, most recent editions.

ACI SP-66	ACI Detailing Manual
ACI 530	Building Code Requirements for Masonry Structures

B. ASTM International (ASTM) standards, most recent editions:

ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM C55	Concrete Building Brick
ASTM C90	Loadbearing Concrete Masonry Units
ASTM C140	Sampling and Testing Concrete Masonry Units and Related Units
ASTM C150	Standard Specification for Portland Cement

ASTM C1314	Standard Test Method for Compressive Strength of Masonry Prisms
ASTM D1056	Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
ASTM D1752	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2000	Standard Classification System for Rubber Products in Automotive Applications
ASTM D2240	Standard Test Method for Rubber Property—Durometer Hardness
ASTM E514	Standard Test Method for Water Penetration and Leakage Through Masonry
ASTM C 578	Specification for Rigid Cellular Polystyrene Thermal Insulation
ASTM C 272	Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions
ASTM E 84	Flame Spread Characteristics
ASTM C 303	Test Method for Density of Preformed Block-type Thermal Insulation
ASTM E 119	Standard Methods of Fire Tests of Building Construction and Materials

C. International Code Council (ICC)

IBC	International Building Code, 2012 edition
ICC-ES	Report ESR-3508 (For Hi-R Block and Insulation Inserts)

D. Underwriters Laboratories Inc. (UL):

Building Materials Directory

1.4 SYSTEM DESCRIPTION

A. Provide masonry with a compressive strength, f'm, of 2,000 psi minimum at 28 days of age.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Product Data
   1. Submit masonry accessory product data.
   2. Submit Hi-R Masonry Data.

C. Shop Drawings: Include, but not limit to, the following:
   1. Complete bar schedule, bar details and erection drawings to conform to ACI SP-66.
   2. Each type of bar marked with identification corresponding to identification tag on bar.
   3. Length, type, and location of all splices.
   4. Erection drawings shall be clear, easily legible and to a minimum scale of:
      a. 1/4 inch = 1 foot.
      b. 1/8 inch = 1 foot if bars in each face are shown in separate views.
   5. Size and location of openings.
   6. Contract Documents shall not be used as erection drawings.
   7. Block layout details at corners and openings for the Hi-R Block showing how the reinforcement and insulation is continuous at these locations.

D. Samples
   1. Submit samples of concrete masonry unit colors with texture ranges for selection of color. Full size samples of the blocks selected shall be submitted for final approval by the Engineer after color selection, if requested. If the material specified is a colored and textured unit, the samples submitted shall be colored and textured units. Samples of mortar colors shall be submitted for color selection by the Engineer.

E. Test Reports
   1. Submit test reports from testing proposed concrete block masonry units showing compliance with ASTM C90 and IBC Table 2105.2.2.1.2, including aggregate data to show conformance to these specifications and cement data to show conformance to ASTM C 150.
   2. Submit test reports from testing masonry prisms.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements
   1. Concrete masonry shall conform to the International Building Code and ACI 530 (ASCE 5) and other applicable codes and standards of the governing authorities.

B. Mock-ups:
   1. Erect an 8-foot minimum high by 8-foot minimum long mock-up panel separate from the Work for approval by the Engineer before starting masonry Work. Upon its approval, it shall remain at the Site as a standard for reference until all masonry Work is completed.
   2. Each sample panel shall include proportionate quantities of required textures and colors of masonry materials as specified herein, and shall include one inside corner, one outside corner, and one 2-foot by 2-foot penetration. The selected colored mortar shall be used when applicable.
   3. If mock-up panel is not acceptable to Engineer, construct additional panels as required.

4. All masonry shall conform to the standard of quality established by the Engineer's acceptance of the mock-up panel.

1.7 WARRANTY

A. Warrant that Hi-R inserts are free of defects and are manufactured to meet physical properties and material specifications.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Maintain all materials clean, dry and protected against dampness, freezing and foreign matter.

C. Store masonry units on pallets and protect from contamination and staining. Keep masonry units covered at all times.

1.9 PROJECT ENVIRONMENTAL REQUIREMENTS

A. General:
   1. Protect masonry from excessive loading during construction. Provide shoring as necessary.
   2. At the end of each day, or at shutdown, cover tops of all walls not enclosed or otherwise sheltered to protect masonry from weather.

B. Temporary Facilities:
   1. Construct and maintain temporary protection required to permit continuous and orderly progress of the Work.
   2. In cold weather, provide and maintain heat sufficient to assure temperature above 32 degrees F within the protected areas.
   3. In hot weather, provide and maintain shade to protect materials and mixing equipment from direct sunlight.
   4. Remove all temporary facilities after completion of the Work.

C. Cold Weather Construction:
   1. Procedures prior to and during installation:
      a. Air temperature: 30 to 40 degrees F.
         1) Heat mixing water and aggregate to produce mortar temperatures between 40 and 120 degrees F at the time of mixing.
      b. Air temperature: 25 to 30 degrees F.
         1) Heat mixing water and aggregate to produce mortar temperatures between 40 and 120 degrees F at time of mixing.
         2) Maintain mortar temperatures above freezing until used.
         3) Heat grout water and aggregate to produce grout temperatures between 70 and 120 degrees F at the time of mixing.
         4) Maintain grout temperatures above 70 degrees F until placed.
      c. Air temperature: Below 25 degrees F.
         1) Do not place masonry.
   2. Procedures after installation:

a. Air temperature: 32 to 40 degrees F.
   1) Protect from rain or snow for not less than 24 hours by covering with weather-resistant membrane.
b. Air temperature: 25 to 32 degrees F.
   1) Completely cover with weather-resistant covering for not less than 48 hours.
c. Air temperature: 20 to 25 degrees F.
   1) Completely cover with weather-resistant insulating blankets for not less than 48 hours or provide other protection approved by Engineer.
d. Air temperature: Below 20 degrees F.
   1) Provide enclosed shelters and heating to maintain air temperature on each side of wall above 32 degrees F. for 48 hours.
   2) Do not allow rapid drop in temperature after removal of heat.

D. Hot Weather Construction:
1. Procedures prior to and during installation:
   a. Air temperature: Above 100 degrees F or above 90 degrees F with a wind velocity greater than 8 mph.
      1) Maintain aggregate piles in damp and loose condition.
      2) Produce mortar having a temperature below 120 degrees F.
      3) Flush mixer, mortar transport container, and mortar boards with cool water before they come into contact with mortar.
      4) Retemper mortar with cool water to maintain proper consistency.
      5) Use mortar within 2 hours of initial mixing.
   b. Air temperature: Above 115 degrees F or above 105 degrees F with a wind velocity greater than 8 mph.
      1) Implement requirements above plus provide shade for materials and mixing equipment to protect from direct sunlight.
   c. Air temperature: Above 120 degrees F.
      1) Do not place masonry.
2. Procedures after installation:
   a. Air temperature: Above 100 degrees F or above 90 degrees F with a wind velocity greater than 8 mph.
      1) Fog spray newly constructed masonry until damp, at least three times each day until the masonry is three days old.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
1. Integral masonry water repellent:
   a. ACM Chemistries, Inc.; RainBloc.
   b. BASF/Master Builders; MasterPel 240.
   c. Grace Construction Products; Dry Block.
   d. Krete Industries, Inc.; Krete HQ (S) Plus
   e. Engineer approved equal.

2. Masonry accessories and horizontal joint reinforcing:
    a. AA Wire Products Co.
    b. Dayton Superior; Dur-O-Wall.
    c. Heckman Building Products, Inc.
    d. Hohmann & Barnard, Inc.
    e. Engineer approved equal.

2.2 MATERIALS

A. Hollow Load Bearing Concrete Masonry Unit (CMU): ASTM C90, medium weight, color and face as shown on Drawings.
    1. Sizes and shapes as indicated on Drawings or as required for conditions.
    2. Face shell and web thickness: ASTM C90, Table 1.
    3. Water Absorption: ASTM C90, Table 2.
    4. Fire resistive units: UL rated.
    5. Special shapes and faces:
        a. For insulated block use Hi-R Masonry Units
        b. Closed cell bond beam units over openings.
        c. Deep knock-out blocks for bond beams in field of the wall.
        d. Sash units for control joints
        e. Architectural faces as shown on the Drawings.

B. Concrete Brick Units:
    1. ASTM C55, of same type and weight as Hollow Load Bearing CMU.

C. Integral Water Repellent: Provide units made with liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water repellent manufacturer's mortar additive according to ASTM E514, with test period extended to 24 hours, show no visible water or leaks on the back of the test specimen.

D. Mortar and Grout: Refer to Section 04 05 12 – Mortar and Grout.

E. Steel Reinforcement: Refer to Section 03 20 00 – Concrete Reinforcing, and as indicated on Drawings.

F. Hi-R® Concrete Masonry Insulation
    1. Description: Inserts complying with ASTM C 578; Standard Type X.
    2. Performance Requirements:
        a. Moisture Absorption: ASTM C 272 – < 1.0% by volume
        b. Flame Spread Characteristics: ASTM E 84 – Flame Spread < 5
        c. Thermal Resistance (R) per inch of thickness at 75° = 5.00
        d. Drainage: Allows full drainage of water in cores of masonry units.
        e. Rot & Vermin Resistance: Produced from expanded polystyrene – fully resistant to rot; does not attract vermin, termites or rodents.
        f. Density: ASTM C 303 – 1.3 lb./cu. Ft.
        g. Components: Insulation shall contain no fluorocarbons and no formaldehyde.
        h. Hourly Rating: ASTM E 119 Insert shall cause no reduction in hourly rating.

i. Shape: Two-piece, interlocking insert shall overlap at both head & bed joints with edges of adjacent inserts of the same type. Keyway shall be provided for butt welded cross-rods of 400 mm (16") o.c. ladder type horizontal wall reinforcement.

3. Product: Hi-R® inserts manufactured by Concrete Block Insulating Systems & available exclusively from Concrete Masonry Block Producers.

G. Sealants: Refer to Section 07 92 00 – Joint Sealants.

H. Bond Breaker Strips: 15-pound asphalt saturated felt.

I. Compressible Joint Filler:
1. Oversized 50 percent to joint width.
2. Closed Cell foam confirming to ASTM D1752, Type I.

J. Back-up Rod:
1. 30 to 50 percent larger than joint width.
2. Conform to ASTM D1056, round, closed cell foam.

K. Control Joints:
1. Solid rubber section 5/8 inch thick with 5/16 inch flange conforming to ASTM D2000.
2. Durometer hardness of 80 when tested in accordance with ASTM D2240.
3. Fit neatly, without forcing, in masonry jamb sash grooves.

L. Embedded Flashing Materials: Reinforced plastic flashing of manufacturer's standard composite plastic flashing as described below.
1. Metal foil, 0.33 mil thick, encapsulated between polyester film and bonded to fiberglass scrim reinforcement, with a total thickness of 7 mil, Dur-O-Wal, “FiberWeb 300", or equal.
2. Joint tape: Reinforced plastic flashing manufacturer's standard polyester tape, 2 inches (50 mm) wide by 2.0 mils thick.
3. Application: Use where flashing is fully concealed in masonry.
4. Adhesive for flashings: Of type recommended by manufacturer of flashing material for use indicated.

M. Steel Lintels, Shelf Angles, and Miscellaneous Steel Shapes:
1. Steel shapes used in masonry construction shall conform to ASTM A36. Lintels and shelf angles shall be provided when shown on the Drawings. These steel members shall be hot-dip galvanized in accordance with ASTM A123.

PART 3 - EXECUTION

3.1 PREPARATION

A. For Hi-R® block examine conditions, with installer present, for compliance with requirements, for installation tolerances and other specific conditions, and other conditions affecting performance of unit masonry

B. Verify that anchors and flashings are correct and in proper location for roughing into masonry work. Beginning of installation means that mason accepts existing conditions.

C. Lay out walls in advance for uniform and accurate spacing of bond patterns and joints. Properly locate openings, embedded items, movement type joints, returns, and offsets.

D. Verify that built-in items are in proper location and ready for roughing into masonry work.

E. Provide temporary bracing during installation of masonry work as required. Maintain in place until building structure provides permanent bracing for the walls.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. General:
1. Build walls to thickness indicated on Drawings.
2. Build single-wythe walls to actual thickness of masonry units.
3. Build in flashing, reinforcing, weeps, and related items.
4. Perform all cutting with masonry saws.
5. Drill holes with power drills when required for piping, conduit, etc.
6. Install all block in running bond. Protect from displacement.
7. Cut as required to maintain bond pattern.
8. Avoid use of less than half-size units, whenever possible.
9. Do not use chipped, cracked, spalled, stained, or otherwise imperfect units exposed in finish work.
10. Build chases and recesses as indicated and required for work of other trades. Provide not less than 8 inches of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.

C. For Hi-R® Concrete Masonry Insulation Inserts:
1. General: Inserts shall be pre-installed by CMU manufacturer prior to delivery to jobsite.
2. Unless otherwise indicated on Construction Documents, inserts shall be left in place when grouting.

D. Concrete Masonry Lintels and Sills:
1. For openings which do not show precast concrete or steel lintels, use concrete masonry lintel units and reinforced concrete fill as shown on Drawings.

E. Laying and Tooling:
1. Lay masonry units with face shells in completely filled bed and head joints.
    a. Butter ends with sufficient mortar to fill head joints and shove into place.
    b. Do not slush head joints.
2. Head joints in lintels shall be mortared solid for full thickness of the wall.
3. Maintain nominal 3/8 inch joint widths.
    a. Tool all joints concave.
    b. During tooling of joints, enlarge any voids or holes and completely fill with mortar.

4. Point-up all joints at corners, openings, and adjacent work to provide neat and uniform appearance.
5. Remove any masonry that is disturbed after laying.
    a. Clean and relay in fresh mortar.
    b. Do not pound units to fit.
    c. If adjustments are required, remove units, clean, and reset in fresh mortar.
6. Toothing of masonry units will not be permitted.
7. Where work is stopped and later resumed, rack back 1/2 masonry unit length in each course.
    a. Remove loose units and mortar prior to laying fresh masonry.
8. As work progresses, build in items indicated on Drawings and specified.
    a. Fill in solidly with mortar around built-in items.
    b. Grout-fill space between door frames and masonry.

F. Reinforcing:
1. Provide continuous horizontal joint reinforcing where indicated on Drawings.
    a. Embed longitudinal side rods in mortar for entire length with minimum cover of 5/8 inch on exterior side of walls and 1/2" at other locations.
    b. Lap reinforcement minimum 12 inches at ends.
    c. Do not bridge control and expansion joints with joint reinforcing.
    d. Make corners and wall intersections by use of prefabricated "L" and "T" sections.
    e. Cut and bend as required.
    f. Install joint reinforcing at 16 inches on center vertically unless noted otherwise on Drawings.
    g. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 24-inches each side of opening, unless otherwise shown on Drawings.
2. Install vertical and horizontal reinforcing bars where indicated on Drawings.
    a. Support and secure reinforcing bars from displacement.
        1) Retain vertical reinforcement in position at top and bottom of each bar and at intervals not exceeding 160 bar diameters.
    b. Unless otherwise shown on the Drawings, the reinforcing bars shall be located as follows:
        1) Single vertical bar; centered in cell.
        2) Double vertical bars; 2-3/4 inches from face of masonry.
        3) Horizontal bars; 4 inches above the bottom of the masonry unit.
    c. Reinforce horizontal bond beams with 2-#4 bars unless otherwise shown on the Drawings.
    d. Lap splices a minimum of 54 bar diameters unless otherwise shown on the Drawings.
3. Bar clearances:
    a. The clear distance between the surface of a bar and any surface of a masonry unit shall not be less than ¼-inch for fine grout and ½-inch for coarse grout. Cross webs of hollow units may be used as support for horizontal reinforcement. All reinforcing bars, except joint reinforcing, shall be completely embedded in mortar or grout and have a minimum cover, including the masonry unit, of at least ¾-inch when not exposed to weather

or soil, 1½-inches of cover when exposed to weather, and 2-inches of cover when exposed to soil.

G. Grout Placement:
   1. For masonry grout lifts 4 feet and higher, cure all masonry for a minimum or 24 hours after placement before beginning grouting operations. Grout lifts less than 4 feet may be placed immediately after setting masonry.
   2. Grout spaces less than 2 inches in width with fine grout using low lift grouting techniques.
   3. Grout spaces 2 inches or greater in width with coarse grout using high or low lift grouting techniques.
   4. When grouting is stopped for more than one hour, terminate grout 1-1/2 inch below top of upper masonry unit to form a positive key for subsequent grout placement.
   5. Low lift grouting:
      a. Place first lift of grout to a height of 16 inches and rod for grout consolidation.
      b. Place subsequent lifts in 8 inch increments and rod for grout consolidation.
   6. High lift grouting:
      a. Clean out masonry cells and cavities.
      b. Pump grout into spaces. Maintain water content in grout to intended slump without aggregate segregation.
      c. Limit grout lift to 48 inches and vibrate or rod for grout consolidation.
      d. Wait 60 minutes before placing next lift.
   7. Fill all cells and cavities for solid grout construction.

H. Lintels, Control Joints, and Sealants.
   1. Provide vertical expansion, control, and isolation joints where indicated on the Drawings.
   2. Refer to Section 07 92 00 – Joint Sealants, for sealant installation requirements.
      a. Seal all control and expansion joints.
      b. Provide reinforced masonry lintels whenever openings more than 12 inches wide are indicated on the Drawings without other structural support or other supporting lintels.
         1) Allow masonry lintels to attain specified strength before removing temporary supports.

3.3 SITE TOLERANCES

A. Maximum variation from plumb in vertical lines and surfaces of columns, walls, and arises:
   1. 1/4 inch in 10 feet.
   2. 3/8 inch in a story height not to exceed 20 feet.
   3. 1/2 inch in 40 feet or more.

B. Maximum variation from plumb for external corners, expansion joints, and other conspicuous lines:
   1. 1/4 inch in any story or 20 feet maximum.
   2. 1/2 inch in 40 feet or more.

C. Maximum variation from level of grades for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:

1. 1/4 inch in any bay or 20 feet.
2. 1/2 inch in 40 feet or more.

D. Maximum variation from plan location of related portions of columns, walls, and partitions:
1. 1/2 inch in any bay or 20 feet.
2. 3/4 inch in 40 feet or more.

E. Maximum variation in cross-sectional dimensions of columns and thicknesses of walls from dimensions shown on the Drawings:
1. Minus 1/4 inch.
2. Plus 1/2 inch.

3.4 FIELD QUALITY CONTROL

A. Inspection:
1. All Work hereunder shall be continuously inspected by a Special Inspector selected by Engineer and approved by the local Building Official having jurisdiction. Special inspection shall be performed in accordance with Chapter 17 of the International Building Code (IBC). The Special Inspector shall work under the direct supervision of Engineer. All costs of such inspection will be borne by Owner.
2. The Special Inspector shall observe the Work for conformance with the design drawings and specifications in accordance with Paragraph 1705.4 of the IBC.

B. Site Tests:
1. Concrete block masonry units shall be sampled and tested in accordance with ASTM C140.
   a. Provide test results minimum of 5 days prior to start of masonry construction.
   b. Remove CMU immediately from site if CMU fails test requirements.
2. Testing of masonry prisms:
   a. Testing of Masonry Prisms: Engineer shall have masonry prisms tested to assure compliance with the Specifications and the governing codes by a recognized testing laboratory.
      1) Tests shall be made in accordance with IBC Section 2105 at the following times:
         a) At the time of the construction of the sample panel, at least 5 masonry prisms shall be made for each type of block indicated herein; except, separate prisms are not required for block which only varies by texture.
         b) At any change in materials during construction, at least 5 masonry prisms shall be made for each type of block affected.
         c) Minimum of one set of at least 5 masonry prisms shall be made for each masonry structure, besides the structure that the sample panel is part of, or for each week in which block is laid, for each type of block involved; whichever occurs first.
         d) Additional sets of at least 5 masonry prisms may be required whenever, in the judgment of Engineer, additional tests are necessary to determine the quality of the materials.

2) The prisms shall be constructed by Contractor in the presence of Engineer or Engineer's representative. The same personnel who are laying the block in the structure shall construct the masonry prism.
3) The masonry prisms shall be constructed and tested as specified in ASTM C1314. The prism shall be grouted after the required 24 hour minimum cure period, using the same grout used in the walls.
4) Compression tests made on sets of specimens made during construction shall include 2 prisms tested at 7 days after grouting and 3 prisms tested at 28 days after grouting.
5) The average compressive strength of prisms tested at 28 days after grouting, shall not be less than the specified masonry compressive strength.

3. Corrective Actions: If the compressive strength of the prisms, made during construction of the sample panel and tested as indicated, fails to meet or exceed the strength required, adjustments shall be made to the mix designs for the mortar, or grout, or both, as needed to produce the specified strength. The masonry units shall also be retested to verify compliance to the requirements of ASTM C 90.
4. If the compressive strength of the prism, made during construction and tested as indicated, fails to meet or exceed that required, prisms or cores shall be cut from the walls constructed in sufficient numbers and in sufficient locations to adequately determine the strength of the walls in accordance with IBC Section 2105. Those portions of the walls represented by specimens failing to meet the required compressive strength are subject to being removed and replaced. Corrective actions as indicated above shall be taken.
5. The costs of tests and test reports except for additional tests requested by Engineer shall be paid by Owner. The costs of the additional tests and reports, when reports verify compliance with the Contract Documents will also be paid by Owner. When tests or reports do not verify compliance, the cost of all additional tests and reports shall be paid by Contractor at no increased cost to Owner.
6. Test samples shall be stored in a moist environment until tested, unless directed otherwise by Engineer or the testing laboratory.

3.5 PROTECTION

A. Protect the exposed faces of the masonry from staining by mortar, grout, weather, or other conditions and materials.

B. When moisture protection is required, use light fog spray nozzles to cure mortar.

C. Protect tops of walls at all times. Cover tops of walls with waterproof paper when rain is imminent and when Work is discontinued.

D. Adequately brace walls until walls and roof are completed. Below grade walls shall not be backfilled until top decks and roofs are in place

E. Provide sufficient bracing to protect walls against damage from elements, including wind and rain.

F. Protect masonry against freezing for a minimum of 72 hours after being laid.

G. Protect masonry from damage until final acceptance of Work. Damaged units will not be accepted.

3.6 CLEANING

A. Clean masonry in accordance with section 04 01 20 Masonry Cleaning.

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METALS

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SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Provide structural steel framing and appurtenant metal parts required for permanent connection of structural steel, complete, in accordance with Contract Documents.

1.2 RELATED SECTIONS

A. Section 03 60 00 – Grouting

B. Section 05 50 00 – Metal Fabrications

C. Section 09 90 01 – Painting and Coating

1.3 REFERENCES

A. American Institute of Steel Construction (AISC) standards, most recent editions:

Manual of Steel Construction, 14th Edition.

Code of Standard Practice for Steel Buildings and Bridges.

Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design.

Structural Joints	Allowable Stress Design Specifications for Structural Joints Using ASTM A325 and A490 Bolts, approved by the Research Council on Structural Connections of the Engineering Foundation.

B. ASTM International (ASTM) standards, most recent editions:

ASTM A6	Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use.
ASTM A36	Specification for Structural Steel.
ASTM A53	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
ASTM A307	Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.

ASTM A325	Specification for Structural Bolts, Steel Heat Treated, 120/105 ksi Minimum Tensile Strength.
ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A992	Standard Specification for Steel for Structural Shapes for Use in Building Framing
ASTM A593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM A594	Standard Specification for Stainless Steel Nuts
ASTM A1085	Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

C. American Welding Society (AWS) standards, most recent editions:

D1.1	Structural Welding Code-Steel

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop drawings:
1. Conform to AISC recommendations and specifications.
2. Show all holes required for other Work.
3. Include complete erection drawings and details showing all members and their connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams showing sequence of erection.
4. Fabricator's drawings shall not include reproductions from Contract Drawings.

C. Test reports:
1. Certified copies of mill tests for material supplied.

D. Surveys:
1. Submit certified copies of each survey conducted by a registered professional engineer or surveyor, showing elevations and locations of base plates and anchor bolts to receive structural steel, and final elevations and locations for major members. Indicate discrepancies between actual installation and contract documents.

1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Steel fabricator: Minimum of 10 years of experience in fabrication of structural steel and be certified under AISC Quality Certification Program, Category BU at time of bid.
      a. AISC Special inspections can be substituted for AISC certification.
   2. Steel erector: Minimum of 10 years' experience in erection of structural steel and be certified under AISC Quality Certification Program, Category CSE at time of bid.
   3. Welders: Use welders with current certifications (previous 12 months at time of bid) for the material, type, and position of welding used. Certify in accordance with AWS Specifications according to AWS D1.1, Structural Welding Code – Steel.
      a. All weld procedures and welder qualifications shall be available in the Contractor's field office for review.
      b. All welding shall be inspected by a Contractor-furnished inspector qualified in accordance with AWS requirements and approved by the Engineer

B. Shop inspection may be required by Owner at Owner's own expense.
   1. Furnish ample notice to Engineer prior to the beginning of fabrication work so that inspection may be provided.
   2. Furnish all facilities for the inspection of materials and workmanship in the shop and allow inspectors free access to the necessary parts of the Work.
   3. Inspectors shall have the authority to reject materials and Work that does not meet Specifications.
   4. Inspection at the shop is intended to facilitate the Work and avoid errors, but will in no way relieve Contractor from the responsibility for providing proper materials and workmanship under this Specification.

C. Owner may engage inspectors to inspect welded connections and high-strength bolted connections, and to perform tests and prepare test reports.
   1. Ten percent of all butt and bevel welds that extend continuously for 24 inches or less will be completely tested in accordance with AWS D1.1, Part B, Radiographic Testing of Welds, Chapter 6. Butt and bevel welds that extend continuously for more than 24 inches will be spot tested at intervals not exceeding 36 inches.
   2. Welds required by Engineer to be corrected shall be corrected or redone and retested as directed, at no additional cost to Owner.
   3. Have tested to failure, three bolts from each heat lot of bolts supplied to the job to verify compliance with Specifications.
      a. Testing laboratory: Approved by Engineer.
      b. Submit test reports to Engineer in accordance with 01 33 20 – Contractor Submittals.
      c. Inspect high-strength bolts using one of the methods set forth in the AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts.

D. Costs for initial testing will be paid for by Owner. Pay costs for additional testing and investigation on Work that does not meet Specifications.
   1. Supply material for testing at no additional cost to Owner.
   2. Provide assistance to Engineer in obtaining material for test samples.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Structural members shall be loaded in such a manner that they may be transported and unloaded without being excessively stressed, deformed, or otherwise damaged.

C. Protect structural steel members and packaged materials from corrosion and deterioration.

D. Store material in a dry area and do not place in direct contact with the ground.
   1. Do not place materials on the structure in a manner that might cause distortion or damage to the members or supporting structures.
   2. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Welded anchor studs.
      a. Nelson Stud Welding Company.
      b. Omark Industries, KSM Fastening Systems Division.
      c. Stud Welding Products, Inc.
      d. Engineer approved equal.

2.2 MATERIALS

A. Wide Flange Steel Shapes: ASTM A992.

B. Other Steel Shapes, Plates, and Bars: ASTM A6 and ASTM A36, unless otherwise shown.

C. Structural Steel Pipe: ASTM A53, Type E or S, Grade B.

D. Structural Tubing: ASTM A500, Grade C or ASTM A1085.

E. Bolts for Connections: ASTM A325, in bearing type connections with threads included in the shear plane (A325N), with standard washers unless noted otherwise. Bolts and nuts used to connect dissimilar metals shall be ASTM F593 and F594, Type 316 stainless steel.

F. Welded Anchor Studs: Headed concrete anchor studs (HAS), or deformed bar anchors (DBA), or threaded studs (TAS), as indicated in the Contract Documents.

G. Non-shrink grout: Refer to 03 60 00 – Grouting.

H. Drill-in anchors: Refer to Section 05 50 00 – Metal Fabrications.

I. Cast-in-place anchor bolts: Provide anchor bolts of size and configuration shown on the Drawings and conforming to ASTM F1554, Grade 36.

J. Galvanizing: ASTM A123 or A653 with minimum coating of 1.5 ounces per square foot.

2.3 FABRICATION

A. Structural steel shall be fabricated in accordance with Contract Drawings, AISC Specifications, and as indicated on shop drawings.

B. Minimize the amount of field welding. Shop assemble components into largest size practical commensurate with transportation and handling limitations.
   1. Shop connections: Bolted with high-strength A325N bolts or welded.

C. One-sided or other types of eccentric connections not indicated in the Contract Documents will not be permitted without prior approval.

D. Accurately mill bearing surfaces to true plane.

E. Cut, drill, or punch holes at right angles to surface of metal.
   1. Do not make or enlarge holes by burning.
   2. Make holes clean cut, without torn or ragged edges.
   3. Remove outside burrs resulting from drilling or reaming operations with a tool making 1/16 inch bevel.
   4. Provide holes in members to permit connection of work of other trades.

F. Headed studs and deformed bar anchors:
   1. Automatically end weld in accordance with AWS code and manufacturer's recommendation.
   2. Fillet welding of headed studs and deformed bar anchors will not be allowed.

G. Cope at 45 degrees, corners of stiffener plates at junction of member flanges with webs.

H. Materials shall be properly marked and match marked for field assembly.

I. Furnish structural members full length without splices unless otherwise indicated.

J. Where finishing is required, assembly shall be completed, including bolting and welding of units, before start of finishing operations.

K. Steel members in contact with dissimilar metals shall be protected from galvanic action by coating contact areas in accordance with Section 05 50 00 – Metal Fabrications, unless indicated otherwise.

L. Clean and coat structural steel in accordance with Section 09 90 00 – Painting and Coating

2.4 WELDING

A. Requirements of this paragraph apply to both shop welding and field welding.

B. Comply with AWS D1.1 and other requirements indicated for all welding, techniques of welding employed, appearance and quality of welds, and methods used to correct defective work.

C. Test and qualify welders, welding operators, and tackers in compliance with AWS D1.1 for position and type of welding to which they will be assigned.

D. Do not perform welding when ambient temperature is lower than 0 degrees F or where surfaces are wet and exposed to rain, snow, or high wind, or where operators are exposed to inclement conditions.

E. When headed stud type shear connectors are to be field applied, clean surface of members to receive studs in shop to remove oil, scale, rust, dirt, and other deleterious materials. Do not shop paint or galvanize metal surfaces to receive field applied studs.

F. Test in-place studs in accordance with requirements of AWS D1.1 qualification procedures to ensure adequate welding of studs to members.

2.5 SHOP PAINT PRIMER

A. Apply shop paint primer in accordance with Section 09 90 01 – Painting and Coating.

B. Provide suitable methods of handling and transporting painted steel to avoid damage to coating.

C. Anchor Bolts:
   1. Anchor bolts in exterior locations shall be hot-dip galvanized to a depth of 1 inch below finished concrete surface.

D. Omit shop applied primer in the following cases:
   1. At field weld locations.
   2. For the portion of a member to be embedded in concrete.
   3. Where galvanizing with no further coating is required.

E. Clean all surfaces thoroughly not coated before shipping. Remove loose mill scale, rust, dirt, oil, and grease. Protect machined surfaces.

2.6 GALVANIZING

A. When specified elsewhere in the Contract Documents, structural steel shall be hot-dip galvanized after fabrication.
   1. Galvanizing: ASTM A123 or A653 with minimum coating of 1.5 ounce per square foot.

B. Provide suitable methods of handling and transporting coated steel to avoid damage to coating.

PART 3 - EXECUTION

3.1 GENERAL

A. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, and diagonal bracing are installed.

B. Plumb, align, and set structural steel members to tolerances listed in the AISC Code of Standard Practice for the type of Work being installed. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and level and in proper alignment until permanent connections are made, the succeeding Work is in place, and temporary measures are no longer necessary. Use temporary guys, bracing, shoring, and other work to prevent damage to adjacent work and existing structures or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind. Remove and dispose of all temporary Work and facilities off-site.

3.2 EXAMINATION

A. Verify dimensions and elevations, make field measurements necessary, and be fully responsible for accuracy and layout of Work.
   1. Specifically check the elevations of all finished footings or foundations to receive steel framing and the alignment of all anchor bolts before starting erection. Notify Engineer of any deviations found by such checking.

B. Review Drawings and report discrepancies to Engineer for clarification prior to starting fabrication.

3.3 FIELD CONNECTIONS

A. Provide bolts for all field connections except where shown otherwise on the Contract Drawings.
   1. Use high-strength A325N bolts unless specifically shown otherwise.
   2. Conform to "Specifications for Structural Joints Using ASTM A325 or A490 bolts."
   3. Standard A307 bolts may be used for attaching steel stair treads to steel stringers.

B. Shop and field connections shall be bolted or welded as indicated. Connections shall develop full strength of members joined and shall conform to AISC standard connections.

3.4 WELDED CONSTRUCTION

A. Comply with current AWS D1.1 Code for procedures, appearance, quality of welds and welders, and methods used in correcting welding Work.
   1. Welded architectural metal Work exposed to view shall have welds ground smooth.
   2. Use shielded metal arc welding method or gas metal arc welding methods for structural steel welding.

B. Unless otherwise indicated, all butt and bevel welds shall be complete penetration.

3.5 HOLES FOR OTHER WORK

A. Provide holes as necessary or as indicated for securing other Work to structural steel framing, and for passage of other Work through steel framing members.

B. No torch cut holes will be permitted.

3.6 ERECTION

A. Comply with AISC Specifications and Code of Standard Practice.

B. Install high strength bolts in accordance with the AISC Specification for Structural Joints Using ASTM A325N bolts. Connections shall be bearing type (threads excluded from shear planes) unless indicated otherwise.

C. Provide anchor bolts and other connectors required for securing structural steel to in-place Work and templates and other devices for presetting bolts and other anchors to accurate locations.

3.7 SETTING BASES AND BEARING PLATES

A. Prior to placement of non-shrink grout beneath base and bearing plates, clean bottom surface of plates of all bond reducing materials, and clean concrete and masonry bearing surface of all bond reducing materials and roughen to improve bonding.

B. Loose and attached base plates and bearing plates for structural members shall be set on wedges, leveling nuts, or other adjustable devices.

C. Tighten anchor bolts after supported members have been positioned and plumbed and non-shrink grout has attained its indicated strength.

D. Grout base plates with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure.

3.8 FIELD ASSEMBLY

A. Set structural frames accurately to the lines and elevations indicated.
   1. Align and adjust various members to form a part of a complete frame or structure before permanently fastening.
   2. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact.
   3. Perform necessary adjustments to compensate for discrepancies in elevations and alignments.

B. Level and plumb individual members of structure within specified AISC tolerances.

C. Required leveling and plumbing measurements shall be established on the mean operating temperature of structure.

3.9 MISFITS AT BOLTED CONNECTIONS

A. Where misfits in erection bolting are encountered, immediately notify Engineer.
   1. Propose a method to remedy the misfit for review by Engineer.
   2. Engineer will determine whether remedy is acceptable or if the member must be refabricated.

B. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by use of drift pins.

C. Pay costs associated with repair of misfits at no increased cost to Owner.

3.10 GAS CUTTING

A. Gas cutting torches shall not be used in the field for correcting fabrication errors in structural framing, except when approved by Engineer.

B. Gas cut sections shall be finished equal to a sheared appearance.

3.11 TOUCH-UP COATING

A. Clean field welds, bolted connections, and abraded areas of shop paint primer immediately after erection.
   1. Apply touchup paint primer by brush or spray at the same thickness and of the same material used for shop paint.
   2. Repair galvanized surfaces that have been field welded or damaged in accordance with Section 05 50 00 – Metal Fabrications.

B. Finish painting of all structural steel shall be as indicated in Section 09 90 01 – Painting and Coating.

END OF SECTION

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SECTION 05 14 00
STRUCTURAL ALUMINUM FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Provide structural aluminum framing and appurtenant metal parts required for permanent connection of structural aluminum, complete, in accordance with Contract Documents.

1.2 RELATED SECTIONS

A. Section 03 60 00 – Grouting

B. Section 05 50 00 – Metal Fabrications

1.3 REFERENCES

A. Aluminum Association (AA) standards, most recent editions:

ADM 1	Aluminum Design Manual, Part 1-A Aluminum Structures, Allowable Stress Design
ASD 1	Aluminum Standards and Data

B. ASTM International (ASTM) standards, most recent editions:

ASTM B209	Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use.
ASTM B211	Specification for Structural Steel.
ASTM B221	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
ASTM B308	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
ASTM B429	Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
ASTM F467	Specification for Structural Bolts, Steel Heat Treated, 120/105 ksi Minimum Tensile Strength.
ASTM F468	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

C. American Welding Society (AWS) standards, most recent editions:

A5.10	Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods
D1.2	Structural Welding Code-Aluminum

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop drawings:
1. Conform to AA recommendations and specifications.
2. Show all holes required for other Work.
3. Submit drawings detailing fabrication and erection of each aluminum fabrication indicated. Include plans, elevations, sections, and details of aluminum fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
4. Fabricator's drawings shall not include reproductions from Contract Drawings.

C. Test reports:
1. Mill Test Reports: Submit mill test reports indicating structural strength, destructive and nondestructive test analysis and chemical analyses from the aluminum used in the Work.

D. Certificates:
1. Welders' Certificates: Documentation certifying welders employed by the Subcontractor meet AWS qualifications.

1.5 QUALITY ASSURANCE

A. Qualifications:
1. Welders: Use welders with current certifications (previous 12 months at time of bid) for the material, type, and position of welding used. Certify in accordance with AWS Specifications according to AWS D1.2, Structural Welding Code – Aluminum.
    a. All weld procedures and welder qualifications shall be available in the Contractor’s field office for review.
    b. All welding shall be inspected by a Contractor-furnished inspector qualified in accordance with AWS requirements and approved by Engineer

B. Shop inspection may be required by Owner at Owner’s own expense.
1. Furnish ample notice to Engineer prior to the beginning of fabrication work so that inspection may be provided if Owner desires.
2. Furnish all facilities for the inspection of materials and workmanship in the shop and allow inspectors free access to the necessary parts of the Work.
3. Inspectors shall have the authority to reject materials and Work that does not meet Specifications.
4. Inspection at the shop is intended to facilitate the Work and avoid errors, but will in no way relieve Contractor from the responsibility for providing proper materials and workmanship under this Specification.

C. Owner may engage inspectors to inspect welded and bolted connections and to perform tests and prepare test reports.
   1. Bolted connections and welds required by Engineer to be corrected shall be corrected or redone and retested as directed, at no additional cost to Owner.

D. Costs for initial testing will be paid by Owner. Pay costs for additional testing and investigation on Work that does not meet Specifications.
   1. Supply material for testing at no additional cost to Owner.
   2. Provide assistance to Engineer in obtaining material for test samples.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Structural members shall be loaded in such a manner that they may be transported and unloaded without being excessively stressed, deformed, or otherwise damaged.

C. Protect structural aluminum members and packaged materials from corrosion and deterioration.

D. Store material in a dry area and do not place in direct contact with the ground.
   1. Do not place materials on the structure in a manner that might cause distortion or damage to the members or supporting structures.
   2. Repair or replace damaged materials or structures as directed by Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural Aluminum: Alloy 6061 – T6 conforming to the following specifications:
   1. Sheet and plate: ASTM B209.
   2. Rolled Bars and Rods: ASTM B211.
   3. Extruded bars, rods, shapes, and tubes: ASTM B221.
   4. Rolled or extruded structural shapes: ASTM B308.
   5. Extruded structural pipe and tube: ASTM B429.

B. Aluminum bolts and nuts: ASTM F467 and F468 of alloy 2024-T4.

C. Bolts and nuts for fastening aluminum to structural steel: Stainless steel bolts, nuts, and washers conforming to Section 05 50 00 – Metal Fabrications.

D. Welding filler metal:
   1. Aluminum alloys conforming to the requirements of AWS A5.10 and AWS classification ER 4043, ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556 as applicable.
   2. For welding of structures which are to be anodized, use filler alloys which will not discolor when anodized; AWS ER 5654, ER5554, ER 5183, ER 5356, or ER 5556.

E. Non-shrink grout: Refer to 03 60 00 – Grouting.

F. Drill-in anchors: Refer to Section 05 50 00 – Metal Fabrications.

2.2 FABRICATION

A. Structural aluminum shall be fabricated in accordance with Contract Drawings, AA Specifications, and as indicated on shop drawings.

B. Minimize the amount of field welding. Shop assemble components into largest size practical commensurate with transportation and handling limitations.

C. Connections: Provide connections as indicated. Where not specifically indicated, design and provide connections in accordance with requirements of this Section. One sided or other types of eccentric connections are not acceptable unless indicated on Contract Documents or approved shop drawings.
   1. Drill and punch holes at right angles to surface of metal. Do not make or enlarge holes by burning. Provide holes clean and free of torn or ragged edges. Use tools which will make a 1/16-inch bevel to remove outside burrs resulting from drilling or punching operations.
   2. Cope corners of stiffener plates at 45 degrees at junction of member flanges and webs.

D. Accurately mill bearing surfaces to true plane.

E. Cope at 45 degrees, corners of stiffener plates at junction of member flanges with webs.

F. Materials shall be properly marked and match marked for field assembly.

G. Furnish structural members full length without splices unless otherwise indicated.

H. Where finishing is required, assembly shall be completed, including bolting and welding of units, before start of finishing operations.

I. Aluminum members in contact with dissimilar metals shall be protected from galvanic action by coating contact areas in accordance with Section 05 50 00 – Metal Fabrications, unless indicated otherwise.

2.3 WELDING

A. Requirements of this paragraph apply to both shop welding and field welding.

B. Perform all welding in accordance with AWS D1.2 and the following:
   1. Preparation:
      a. Remove dirt, grease, forming or machining lubricants, and organic materials from areas to be welded by cleaning with a suitable solvent or by vapor degreasing.
      b. Additionally, etch or scratch brush to remove oxide coating just prior to welding when inert gas tungsten arc welding method is used.
      c. Oxide coating may not need to be removed if welding is performed by automatic or semi-automatic inert gas shielded metal arc.
      d. Suitably prepare edges to assure 100 percent penetration in butt welds by sawing, chipping, machining, or shearing. Do not cut with oxygen.

2. Perform welding by using a non-consumable tungsten electrode with filler metal in an inert gas atmosphere (TIG) or using a consumable filler metal electrode in an inert gas atmosphere (MIG).
3. Do not use welding processes that require use of a welding flux.
4. Neatly make welded closures.
5. Where weld material interferes with fit or is unsightly in appearance, grind it smooth.
6. Make welds full penetration welds unless otherwise indicated on Contract Drawings.

C. Do not perform welding when ambient temperature is lower than 0 degrees F or where surfaces are wet and exposed to rain, snow, or high wind, or where operators are exposed to inclement conditions.

PART 3 - EXECUTION

3.1 GENERAL

A. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, and diagonal bracing are installed.

B. Plumb, align, and set structural aluminum members to tolerances listed in the AA ADM 1 for the type of Work being installed. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and level and in proper alignment until permanent connections are made, the succeeding Work is in place, and temporary measures are no longer necessary. Use temporary guys, bracing, shoring, and other work to prevent damage to adjacent work and existing structures or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind. Remove and dispose of all temporary Work and facilities off-site.

3.2 EXAMINATION

A. Verify dimensions and elevations, make field measurements necessary, and be fully responsible for accuracy and layout of Work.
1. Specifically check the elevations of all finished footings, walls, or foundations to receive aluminum framing and the alignment of all anchor bolts before starting erection. Notify Engineer of any deviations found by such checking.

B. Review Drawings and report discrepancies to Engineer for clarification prior to starting fabrication.

3.3 ERECTION

A. Rigidly support or brace structural aluminum products needing special alignment to preserve straight, level, even, smooth lines, and keep braced until concrete, grout, or dry pack mortar has hardened for a minimum 48-hour period.

B. To the maximum extent possible, weld connections to members in the shop and bolt connections in the field.

3.4 FIELD CONNECTIONS

A. Bolting:
   1. Unless otherwise shown on Contract Drawings, connect aluminum members to other aluminum members using 3/4-inch aluminum bolts. Connect aluminum members to structural steel using 3/4-inch stainless steel bolts. Connect aluminum members to concrete or masonry using 3/4-inch stainless steel epoxy anchors per Section 05 50 00 Metal Fabrications.
   2. Where aluminum members are connected to masonry supports, place connection bolts into masonry cells filled with concrete or masonry grout.
   3. Concrete and masonry anchors require a minimum embedment of 5-1/2 inches into masonry or concrete unless indicated otherwise on Contract Drawings.
   4. Protect bolt threads from damage during driving. Rest bolt heads and nuts squarely against surfaces. Where bolt heads or nuts rest on beveled surfaces having slope greater than 1 in 20 with plane normal to bolt axis, provide beveled washers to give full bearing to head and nut. Correct poor matching of holes by drilling to next larger size and use larger diameter bolt.

B. Welding:
   1. Perform welding in accordance with AWS D1.2. Use only welding procedures and welding operators qualified in accordance with the requirements of this Section. Field welding of aluminum is not allowed unless specifically indicated on the Contract Drawings.

3.5 HOLES FOR OTHER WORK

A. Provide holes as necessary or as indicated for securing other Work to structural aluminum framing, and for passage of other Work through aluminum framing members.

B. No torch cut holes will be permitted.

3.6 SETTING BASES AND BEARING PLATES

A. Prior to placement of non-shrink grout beneath base and bearing plates, clean bottom surface of plates of all bond reducing materials, and clean concrete and masonry bearing surface of all bond reducing materials and roughen to improve bonding.

B. Loose and attached base plates and bearing plates for structural members shall be set on wedges, leveling nuts, or other adjustable devices.

C. Tighten anchor bolts after supported members have been positioned and plumbed and non-shrink grout has attained its indicated strength.

D. Grout base plates with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure.

3.7 FIELD ASSEMBLY

A. Set structural frames accurately to the lines and elevations indicated.

1. Align and adjust various members to form a part of a complete frame or structure before permanently fastening.
2. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact.
3. Perform necessary adjustments to compensate for discrepancies in elevations and alignments.

B. Level and plumb individual members of structure within specified tolerances.

C. Required leveling and plumbing measurements shall be established on the mean operating temperature of structure.

3.8 MISFITS AT BOLTED CONNECTIONS

A. Where misfits in erection bolting are encountered, immediately notify Engineer.
1. Propose a method to remedy the misfit for review by Engineer.
2. Engineer will determine whether remedy is acceptable or if the member must be refabricated.

B. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by use of drift pins.

C. Pay costs associated with repair of misfits at no increased cost to Owner.

3.9 GAS CUTTING

A. Gas cutting torches shall not be used in the field for correcting fabrication errors in structural framing, except when approved by Engineer.

B. Gas cut sections shall be finished equal to a sheared appearance.

3.10 PROTECTION

A. Suitably protect aluminum surfaces against lime mortar stains, discoloration, surface abrasion, and other construction abuses.

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SECTION 05 21 00
STEEL JOISTS FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Provide pre-engineered steel joists in accordance with Contract Documents.

1.2 RELATED SECTIONS

A. Section 03 60 00 – Grouting

B. Section 05 50 00 – Metal Fabrications

C. Section 09 90 01 – Painting and Coating

1.2 REFERENCES

D. American Institute of Steel Construction (AISC) standards, most recent editions:
   1. Specifications for Structural Steel Buildings.
   2. Code of Standard Practice for Steel Buildings and Bridges.

E. ASTM International (ASTM) standards, most recent editions:

ASTM A307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
ASTM A325	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

F. American Welding Society (AWS) standards, most recent editions:

D1.1	Structural Welding Code-Steel.

G. Steel Joist Institute (SJI) standards, most recent edition.

Recommended Code of Standard Practice for Steel Joists and Joist Girders.

Standard Specifications for Open Web Steel Joists, K-Series.

Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series.

Technical Digest #8, "Welding of Open Web Steel Joists."

H. Society for Protective Coatings (SSPC) standards, most recent edition:

SSPC-Paint 15	Steel Joist Shop Primer/Metal Building Primer.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop drawings:
   1. Detailed shop drawings showing size and layout of joist units, bridging, connections, and accessories. Include mark, number, type, locations, and spacing of joists and bridging.
   2. Provide templates or location drawings for installation of any required anchor bolts.
   3. Indicate beveled end plates for joist roof pitch where required. Provide details of bridging, method of attachment to joists, and joist end anchorage and other details required for joist installation.
   4. Shop drawings shall not be reproductions of the Contract Drawings.

C. Certifications:
   1. Submit evidence that joist manufacturer is a member of the Steel Joist Institute (SJI).
   2. Welding certifications.
   3. Capability of joist in accordance with Paragraph 2.2 B.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Fabricator: Fabricator shall be a member of the Steel Joist Institute who regularly produces steel joists of the K-, KCS-, LH-, and DLH-Series, or joist girders conforming to SJI Specifications and Load Tables and whose designs have been checked and accepted by the SJI.
   2. Erector: Use erectors with a minimum of 5 years' experience installing steel joists equal in material, design, and scope to the trusses required for this Project.
   3. Welders:
      a. Qualify welding processes, operations, and operators in accordance with AWS D1.1 and SJI Technical Digest #8, "Welding of Open Web Steel Joists."
      b. Welding operators to have been qualified during the 12 month period prior to commencement of welding.
   4. Joist designer: The design professional, licensed to practice in the state of Utah, having responsibility for the design of the joists. The joist designer shall be either an employee of the joist fabricator or a consultant.

B. Shop inspection may be required by Owner at Owner’s own expense and option.
   1. Furnish ample notice to Engineer prior to the beginning of fabrication work so that inspection may be provided.
   2. Furnish all facilities for the inspection of materials and workmanship in the shop and allow inspectors free access to the necessary parts of the Work.
   3. Inspectors shall have the authority to reject materials and Work that does not meet Specifications.
   4. Inspection at the shop is intended to facilitate the Work and avoid errors, but will in no way relieve Contractor from the responsibility for providing proper materials and workmanship under this Specification.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Deliver materials to site at such intervals to ensure uninterrupted progress of Work. Inspect the joists for damage before unloading and note any permanent bend or deformation or broken welds on the receiving documents.

C. Store materials to permit easy access for inspection and identification. Keep joist members off ground using pallets, skids, platforms, or other supports.

D. Protect steel members from corrosion and damage.

E. Store packaged materials in original unbroken package or container.

F. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures.

G. Replace damaged shapes or members as required by Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Steel joists:
      a. CANAM Steel Corporation.
      b. Nucor Corporation, Vulcraft Divisions
      c. Valley Joist, Incorporated.
      d. Engineer approved equal.

2.2 STEEL JOIST

A. Provide steel joists that have been designed for loadings and configurations specified on the Contract Drawings and that have been found to conform to the SJI standard specifications.

B. Special or concentrated loads:
   1. Where special loadings and concentrated loads are indicated in the Contact Documents, reinforce joist and develop details as necessary for support of such loads.
   2. Submit written certification that the joist(s) have been designed, fabricated, and are capable of supporting the loadings indicated for the span(s) shown. Written certification to be signed and sealed by a professional engineer licensed to practice in the state of Utah.

C. Design in accordance with SJI Specifications:
   1. Joist designations indicated on the Contract Drawings are minimum requirements. Increase as required to comply with design requirements specified.

2. Whenever possible, increased joists shall have the same depth as joist indicated on Contract Drawings.
3. When necessary to increase joist depths to meet design requirements, coordinate all Project changes required due to the increased depth at no additional cost to Owner.

D. Bridging: Provide horizontal or diagonal type bridging as required by SJI specifications or as indicated on Contract Drawings for type of joist, chord size, spacing and span.
1. Supply bridging to ensure stability of structure during construction period.

E. Extended ends: Provide extended ends on joists as indicated on Contract Drawings complying with applicable SJI specifications and load tables.

F. Top chord extension: Top chord extensions shall be capable of withstanding the full uniform load of the joist plus any concentrated loads shown on the Contract Documents. The extensions shall be attached to the perimeter bracing unless shown otherwise on the Contract Drawings.

G. Bottom chord extension: Provide bottom chord extensions of sufficient strength to support ceiling construction when ceilings are shown on the Contract Documents.
1. Provide either an extended bottom chord or a separate unit of sufficient strength to support ceiling construction.
2. Extend ends to within 1/2 inch of wall surface.

2.3 MATERIALS

A. Steel: Comply with requirements of SJI specifications.

B. Unfinished threaded fasteners: ASTM A307, Grade A, regular hexagon type, low carbon steel.

C. High-strength bolts and nuts: ASTM A325, Type I, heavy hex structural bolts, heavy hex nuts and hardened steel washers.

D. Accessories: Provide accessories required for erection of steel joists, complying with SJI specifications and Contract Drawings.

2.4 FABRICATION

A. Fabricate in accordance with SJI specifications and as follows:
1. Do not splice principal tension members. Use only full length pieces.
2. Make shop connections and splices using either arc or resistance welding. Do not shop-bolt connections.
3. Design and fabricate for maximum deflection of 1/240 of clear span under design live load.
4. Shop holes, field holes, and enlargement of holes will not be permitted unless approved by Engineer.
5. Fabricate bearing ends to provide following minimum bearing unless a longer bearing length is shown or specified.

Support	"LH" and "DLH" Joists	"K" and "KCS" Joists	Joist Girders
On Masonry or Concrete.	6 inches min	4 inches min	6 inches min
On Steel.	4 inches min	2-1/2 inches min	4 inches min

2.5 SHOP COATING

A. Apply shop primer of red oxide, lead-free and cadmium-free, corrosion inhibiting primer complying with performance requirements of SSPC Paint Specification No. 15, Type I.

A. Limit shop coating to primer which is compatible with specified finish paints.

B. Refer to Section 09 90 01 – Painting and Coating. Coordinate shop primer, surface preparation, and coating with field applied primers and coatings where specified.

C. Provide suitable methods of handling and transporting painted steel joists to minimize damage to coating.

D. Do not coat following surfaces:
   1. Surfaces adjacent to field welds and surfaces fully embedded in concrete.
   2. Joists scheduled to receive fireproofing.
   3. All other joists for which no coating is specified.

E. Thoroughly clean all surfaces not coated before shipping. Remove loose mill scale, rust, dirt, oil, and grease.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which steel joists are to be installed for conditions detrimental to proper and timely completion of Work.

B. Do not proceed with Work until unsatisfactory conditions have been corrected.

C. Do not start placement of steel joists until supporting Work is in place and secured.

D. Joists shall be subject to rejection if:
   1. Joists do not comply with requirements of SJI specifications and requirements included herein and on the approved shop drawings.
   2. Joists are improperly welded or constructed.
   3. Joists are damaged so that strength is impaired.
   4. Joists are not installed as indicated on Contract Drawings.
   5. Joists are not installed straight within a tolerance as plus or minus 0.0028 times the length of the joist or the distance between points of lateral support.

E. Review Drawings and report discrepancies to Engineer for clarification prior to starting fabrication or erection.

3.2 INSTALLATION

A. Do not install joists that are damaged such that strength is impaired.

B. Provide proper lifting equipment, including spreader bar, suited to sizes and types of joists required, applied at lift points recommended by joist manufacturer. Exercise care to avoid damage to joist members during erection and to keep horizontal bending of the joists to a minimum.

C. Where not specifically indicated otherwise, place and secure steel joists in accordance with SJI specifications and as herein specified.

D. Bearing on Masonry or Concrete Bearing Surfaces:
   1. Secure joists resting on masonry or concrete bearing surfaces by welding to embedded plates anchored to masonry or concrete construction as shown on Drawings. Masonry or concrete required to support joists to have reached required 28 day compressive strength prior to placing joists thereon.
   2. Furnish steel bearing plates to be built into concrete and masonry construction. Furnish templates as may be necessary for accurate location of anchors. Steel bearing plates to conform to requirements of Section 05 50 00 – Metal Fabrications.
   3. Bedding mortar (grout): Non-shrink grout in accordance with Section 03 60 00 – Grouting.

E. Place joists on supports at spacing indicated on the shop drawings. Adjust and align in accurate location and spacing before permanently fastening.
   1. When joists do not bear flush on supporting member or wall, take corrective measures to ensure full bearing. Provide tapered bearings as required for uniform flush bearing.

F. Bridging: Install bridging simultaneously with joist erection, before construction loads are applied.
   1. Comply with OSHA requirements for bolted bridging to be in place before slackening lines on joist longer than 40 feet.
   2. Anchor ends of bridging lines at top and bottom chords of each joist and where terminating at walls or beams.
   3. Provide bridging connections at top and bottom chords capable of safely resisting a force specified by SJI standard specifications for open web, long span, deep long span joists, and joist girders, respectively.
   4. During construction period, CONTRACTOR shall be responsible for loads placed on joists. Joists may be unstable and cannot carry design load until steel deck and bridging are completely installed.
   5. Provide bracing that holds trusses straight and plumb and in safe condition until decking and permanent truss bracing has been fastened to form a structurally sound framing system.

G. Removal, cutting, or other alteration of any joist chord, web, or bridging member in the field is prohibited, unless approved in advance and in writing by Engineer and joist manufacturer.

H. Remove and replace or repair damaged joists or other Work as directed by Engineer and/or joist manufacturer at no additional expense to Owner.

3.3 TOUCH-UP PAINTING:

1. Clean abraded, corroded, and field-welded areas and touch up with same type of paint used for shop coating.
2. Field paint as specified in Section 09 90 01 – Painting and Coating.

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SECTION 05 31 00
STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Provide steel decking, accessories, fastenings, and complete appurtenant work in accordance with Contract Documents.

1.2 RELATED SECTIONS

A. Section 09 90 01 – Painting and Coating

1.3 REFERENCES

A. American Iron and Steel Institute (AISI) standards, most recent editions:

Specifications for the Design of Cold-Formed Steel Structural Members.

B. ASTM International (ASTM) standards, most recent editions:

ASTM A36	Specification for Carbon Structural Steel.
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
ASTM A924	Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
ASTM D746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
ASTM D1056	Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.

C. American Welding Society (AWS) standards, most recent editions:

D1.1	Structural Welding Code-Steel.
D1.3	Structural Welding Code-Sheet Steel.

D. Steel Deck Institute (SJI) standards, most recent edition.

Design Manual for Composite Decks, Form Decks, and Roof Decks.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Prodedures.

B. Detailed shop drawings, fabrication, and/or layout drawings showing the following:
   1. Complete framing and erection layouts.
   2. Location, length, and markings of steel deck units that correspond with sequence and procedure to be followed for erecting, fastening, and securing the deck units.
   3. Details and gauges of accessories and miscellaneous items showing sump pans, cant strips, ridge and valley plates, closure strips, and insulation supports.
   4. Fastening procedures for installation including screw size, number, type, and location of all screws required to install deck units.
   5. Correct fitting of members and accessories.
   6. Size and location of openings in deck and all conditions requiring closure panels.
   7. Shop drawings shall not be reproductions of the Contract Drawings.

C. Product technical data including:
   1. Letter of certification that products submitted meet requirements of standards referenced.
   2. Metal deck manufacturer's specifications and installation instructions.
   3. Manufacturer's specification and installation instructions for:
      a. Galvanizing repair paint.
      b. Fasteners.
   4. Manufacturer's load tables for deck to be furnished on this project, including allowable gravity load for roof and allowable diaphragm shear values for deck and fasteners specified.

D. Certifications:
   1. Steel deck manufacturer member of SDI or ICC-ES Report.
   2. Welders' quality assurance report.

1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Welding:
      a. Qualify welding processes, operations, and operators in accordance with AWS D 1.1 and D1.3.
      b. Welding operators shall have been qualified during the 12 month period prior to commencement of welding, and be experienced in welding light gauge metal.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Deliver materials to site at such intervals to ensure uninterrupted progress of Work.

C. Store materials to permit easy access for inspection and identification. Keep deck panels off ground using pallets, skids, platforms, or other supports.

D. Protect steel decking from corrosion and damage.

E. Store packaged materials in original unbroken package or container.

F. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures.

G. Replace damaged deck panels as required by Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Steel roof deck:
      a. BHP Steel Building Products USA, Inc.
      b. Consolidated Systems, Inc.
      c. Epic Metals Corporation.
      d. Nucor Corporation, Vulcraft Division.
      e. Verco Manufacturig Company.
      f. Wheeling Corrugating Company.
      g. Engineer approved equal.
   2. Steel form deck (composite):
      a. BHP Steel Building Products USA, Inc.
      b. Consolidated Systems, Inc.
      c. Epic Metals Corporation.
      d. Nucor Corporation, Vulcraft Division
      e. Verco Manufacturig Company.
      f. Wheeling Corrugating Company
      g. Engineer approved equal.

2.2 MATERIALS

A. Galvanized sheet steel:
   1. ASTM A653, Structural Quality.
   2. 1 1/2 inch nominal depth.
   3. Minimum uncoated thickness: 0.034 inch (20 Gage) unless otherwise indicated on Contract Drawings.
   4. Minimum yield strength: 38 ksi.

B. The allowable superimposed live uniform loading per square foot for the deck supplied and the spans indicated shall equal or exceed the allowable superimposed live uniform load per square foot for the same spans as indicated in the Steel Deck Institute's latest tables.

Provide composite steel form deck to act as bottom form for cast-in-place concrete slabs and which will remain permanently in place. Deck shall have deformations and indentations to provide a mechanical bond with the concrete.

C. Metal closures:
   1. Manufacturer's standard, 20 gauge minimum thickness.
   2. Finish: galvanized.

D. Pour stops: Provide pour stops as required adequate to support concrete and any construction loads.

E. Drain sump pan:
   1. Galvanized steel not less than 0.071 inch thick.
   2. Recessed 1 1/2 inches below deck surface with bearing flange not less than 3 inches wide and all joints sealed watertight.

F. Galvanized coating for metal decks and accessories shall conform to ASTM A924, with a minimum coating class of G90 as defined in ASTM A653.

G. Galvanizing repairs: Prepare and repair damaged galvanized coatings on deck panels and accessories according to ASTM A780.

H. Screws: Self-drilling, self-tapping sheet metal screws unless otherwise indicated on the Contract Drawings.

I. Miscellaneous steel shapes: Comply with ASTM A36.

J. Flexible closure strips for deck:
   1. Vulcanized, closed cell expanded chloroprene elastomer conforming to ASTM D1056, Grade SCE 41.
   2. Brittleness temperature: -40 degrees F, ASTM D746.
   3. Flammability resistance: Self-extinguishing.

K. Sheet metal accessories: Same material and finish as deck members.

2.3 FABRICATION

A. Form deck units in length to span 3 or more support spacings with flush, telescoped, or nested 2-inch end laps.
   1. Joints occur on supporting members.
   2. Provide deck units having interlocking male and female type side laps or joints to provide positive vertical and lateral alignment of adjacent deck units.

B. Use deck configurations complying with SDI Basic Design Specifications and as indicated.

C. Metal closure strips: Form to configuration required to provide tight-fitting closures at open ends and sides of decking.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Review all discipline Contract Drawings and report discrepancies to Engineer for clarification prior to starting fabrication or erection. Inform Engineer of any openings that will require steel frames that are not shown on the Contract Drawings.

B. Verify that all edge angles are in place with proper attachment prior to installation of steel deck. All roof and floor opening frames are to be installed prior to deck installation.

C. Examine field conditions and substrates to receive steel decking and verify that existing conditions are acceptable before commencing installation.

3.2 INSTALLATION

A. Install deck units and accessories as indicated in accordance with manufacturer's recommendations, final approved shop drawings, and as specified.

B. Do not start placement of deck units until supporting members are installed complete. Locate deck bundles to prevent overloading of structure.

C. Do not overload supporting members. Until the entire assembly is complete, the structural elements may not be stable or capable of supporting code or stated design loads.

D. Place each deck unit on supporting structural frame, adjust to final position, and accurately align with ends bearing on supporting members.
   1. Lap units as ends no less than 2 inches.
   2. Do not stretch or contract side-lap interlocks.
   3. Place deck units flat and square and secure to framing without warp or excessive deflection.
   4. Place units in accurate and close alignment for entire length of run and with close registration of flutes of one unit with those of abutting unit.

E. Fastening of Metal Decks:
   1. Fastening pattern shall be as required for shears shown on Contract Drawings.
   2. Minimum connection shall be as shown on Contract Drawings.
   3. Weld metal shall penetrate all layers of deck material at end laps and have good fusion to supporting members. Do not burn through support members.
   4. At sheet metal closures used at ends or sides: Self-drilling sheet metal screws at 2 feet on center.

F. Remove and replace decking that is structurally weak or unsound or that has burn holes due to improper welding or that Engineer declares defective.

G. Cut and fit deck units and accessories around other Work projecting through or adjacent to decking.
   1. Make cutting and fitting neat, square, and trim. Cut deck by mechanical means, not by burning.
   2. Neatly and accurately install reinforcing at all openings except:

a. Circular openings less than 6 inches in diameter.
b. Rectangular openings having no side dimension greater than 6 inches.

3. Reinforce openings that have not been framed between 6 and 12 inches with 20 gauge flat steel sheet 12 inches greater in each dimension than opening. Place sheet around opening and fasten with #10 sheet metal screws to top surface of deck at each corner.

H. Install metal closure strips for support of roof insulation.
1. Provide where rib openings in top surface of roof decking occur adjacent to edge and openings.
2. Fasten closure strips into position with self-drilling sheet metal screws.

I. Install metal closure strips at open uncovered ends and edges of roof decking, and in voids between decking and other construction.
1. Fasten into position with self-drilling sheet metal screws to provide a complete decking installation.
2. Provide flexible closure strips instead of metal closures, at Contractor's option and when approved by Engineer wherever their use will ensure complete closure. Install with elastomeric type adhesive in accordance with written directions and recommendations of manufacturers of closure strips and adhesives.

J. Roof sump pans:
1. Place over openings in roof deck.
2. Fasten into position with self-drilling sheet metal screws. Space screws at 12 inches maximum with at least one screw at each corner and each side midway between each corner.
3. Cut opening in bottom of roof sump to accommodate drain size indicated.

K. Install metal closures to close all openings and gaps between floor decking and other construction, at objects projecting through deck, at locations where deck changes direction, and at open ends of deck units where deck units terminate.

3.3 TOUCH-UP PAINTING:
1. Remove surplus materials and debris from surface of deck after installation.
2. Wire brush, clean, and paint scarred areas, welds, and rust spots on top surfaces of decking units and supporting steel members in compliance with Section 09 90 00 – Painting and Coating.
3. Touch-up damaged galvanized surfaces with galvanizing repair paint applied in accordance with manufacturer's instructions.

3.4 FIELD TESTING

A. The following test shall be made in the presence of Engineer on the first deck panel to be installed.

B. Place one end of panel over a perimeter support and attach it only to that support with 2 self-drilling sheet metal screws or welds as specified, 6 inches apart.

C. The opposite end of the panel shall be moved in place perpendicular to the span of the panel until shear distress is noted around the fasteners.

D. Fasteners: Of sufficient quality to cause local distortions in the panel around the fastener and show good perimeter contact between the fastener and the panel.

E. When the results of this test are satisfactory and approved by Engineer, the remainder of the deck may be installed using the same fastener type, size, and procedures used in the tested deck.

F. The remainder of the fasteners shall be visually inspected.
   1. When, in opinion of Engineer, fastener is of poor quality, provide additional fastener adjacent to the rejected one.
   2. Replacement fastener shall be sufficient distance away from the rejected fastener so that the new fastener will be on sound deck.

END OF SECTION

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SECTION 05 50 00
METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish, fabricate, and install metal fabrications in accordance with Contract Documents.

1.2 RELATED SECTIONS

A. Section 05 12 00 – Structural Steel Framing

B. Section 05 14 00 – Structural Aluminum

C. Section 05 51 13 – Metal Pan Stairs

D. Section 05 52 00 – Pipe and Tube Railings

E. Section 07 72 00 – Roof Accessories

F. Section 09 90 01 – Painting and Coating

G. Section 09 97 01 – Pipeline Coatings and Linings

1.3 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM A6	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A36	Specification for Structural Steel
ASTM A47	Standard Specification for Ferritic Malleable Iron Castings
ASTM A48	Gray Iron Castings
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A123	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
ASTM A197	Standard Specification for Cupola Malleable Iron
ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength

ASTM A325	Specification for Structural Bolts, Steel Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A563	Specification for Carbons and Alloy Steel Nuts
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A666	Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTMA668	Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A992	Standard Specification for Steel for Structural Shapes for Use in Building Framing
ASTM A1085	Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)
ASTM B209	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B211	Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire
ASTM B221	Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B308	Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM B429	Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM F593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Standard Specification for Stainless Steel Nuts
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

B. American National Standards Institute (ANSI) standards, most recent editions:

ANSI A14.3	Standard for Ladders - Fixed - Safety Requirements

C. American Welding Society (AWS) Standards, most recent editions:

AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code – Aluminum
AWS D1.6	Structural Welding Code – Stainless Steel
AWS QC1	Specification for AWS Certification of Welding Inspectors
AWS Welding Handbook	

D. American Water Works Association (AWWA) standards, most recent editions:

AWWA C105	American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C217	Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines

E. National Sanitation Foundation (NSF), most recent edition:

NSF 61	Drinking Water System Components, Health Effects.

F. Federal Specifications:

MIL-A-907E	Anti-seize Thread Compound, High Temperature

G. Occupational Safety and Health Administration (OSHA), most recent editions:

OSHA 1910.27	Fixed Ladders

H. Society for Protective Coatings (SSPC):

SSPC-PA 1	Shop, Field, and Maintenance Painting of Steel

1.4 DEFINITIONS

A. Metal Fabrications: Defined as items to be fabricated from metal shapes, plates, or bars and their products.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop Drawings: Submit shop drawings of all metal fabrications to the Engineer for review.

1. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
2. Submit layout drawings for grating showing the direction of span, type and depth of grating, size and shape of grating panels, seat angle details, and details of grating hold down fasteners. Submit load and deflection tables for each style and depth of grating used.

C. Submit ICC-ES report listing the ultimate load capacity in tension and shear for each size and type of concrete anchor submitted. Submit manufacturer's recommended installation instructions and procedures for adhesive anchors. Upon review, by Engineer, these instructions shall be followed specifically.

D. No substitution for the indicated adhesive anchors will be considered unless accompanied by an ICC-ES report verifying strength and material equivalency, including temperature at which load capacity is reduced to 90 percent of that determined at 75 degrees F.

1.6 QUALITY ASSURANCE

A. All weld procedures and welder qualifications shall be available in the Contractor's field office for review.

B. Qualification of Welders: Use welders with current certifications (previous 12 months) for the material, type, and position of welding used. Certify in accordance with AWS Specifications according to the following:
1. AWS D1.1, Structural Welding Code – Steel.
2. AWS D1.2, Structural Welding Code – Aluminum.
3. AWS D1.6, Structural Welding Code – Stainless Steel.

C. All welding shall be inspected by a Contractor-furnished inspector qualified in accordance with AWS requirements and approved by the Engineer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Metal fabrications shall be loaded for transport in such a manner that they may be transported and unloaded without being excessively stressed, deformed, or otherwise damaged.

C. Protect metal fabrications from corrosion and deterioration.

D. Store material in a dry area and do not place in direct contact with the ground.
1. Do not place materials on the structure in a manner that might cause distortion or damage to the members or supporting structures.
2. Repair or replace damaged materials or structures as directed.

1.8 PROJECT CONDITIONS

A. Check actual locations of walls and other construction to which metal fabrications must fit by accurate field measurements before fabrication. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabricating products without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Safety stair nosings.
      a. American Abrasive Metals Company.
      b. American Mason Safety Tread Company.
      c. Wooster Products, Inc.
      d. Engineer approved equal
   2. Concrete and masonry anchors:
      a. Hilti, Inc.
      b. ITW Ramset/Redhead.
      c. Simpson Strong Tie Company, Inc.
      d. Engineer approved equal.
   3. Castings, trench covers, and accessories:
      a. D&L Foundry and Supply
      b. Deeter Foundry company.
      c. Neenah Foundry Company.
      d. Engineer approved equal.
   4. All purpose metal framing
      a. Allied Tube and conduit.
      b. B-Line Systems.
      c. Unistrut Building Systems.
      d. Engineer approved equal.
   5. Steel Ladder Rungs:
      a. Perforated “Traction Tread”; McNichols, Co.
      b. Engineer approved equal.
   6. Floor hatches:
      a. Babcock Davis Associates.
      b. Bilco Company.
      c. Dur-Red Products.
      d. Engineer approved equal.
   7. Anti-seize lubricant:
      a. AS-470 by Dixon Ticonderoga
      b. PURE WHITE by Anti-Seize Technology

c. Engineer approved equal.

2.2 MATERIALS

A. Steel: Refer to Section 05 12 00 – Structural Steel Framing.

B. Steel Forgings: ASTM A668.

C. Stainless steel: ASTM A666 and ASTM A276, Type 316 or 316L

D. Aluminum: Refer to Section 05 14 00 – Structural Aluminum.

E. Iron:
1. Ductile iron: ASTM A536.
2. Gray cast iron: ASTM A48.
3. Malleable iron: ASTM A47, A197.

F. Bolts and Anchors:
1. Standard Service (non-corrosive applications): Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be steel as indicated herein. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, steel for bolt material, anchor bolts, and cap screws shall be in accordance with the following:
   a. Anchor bolts: ASTM F1554, Grade 36, of dimensions indicated, with nuts conforming to ASTM A563 and flat washers where indicated.
   b. Install high-strength structural connections using ASTM A325 bolts and nuts per ASTM A563, coated to match material being connected.
2. Corrosive Service: All bolts, nuts, and washers in the locations listed below shall be stainless steel.
   a. All buried locations except as noted below for pipe flange, fitting and coupling connections.
   b. All submerged locations.
   c. Inside hydraulic structures, below the top of the structure.
   d. Inside buried vaults, manholes, and structures that do not have a forced-air ventilation system and either a gravity drain or a sump with a sump pump.
   e. All chemical handling areas.
   f. Other locations indicated by the Contract Documents or designated by the Engineer to be provided with stainless steel bolts.
3. Stainless steel bolts, anchor bolts, nuts, and washers shall be Type 316 stainless steel, conforming to ASTM F593F for bolts and to ASTM F594 for nuts. Protect all threads on stainless steel bolts with an anti-seize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E and classified as acceptable for potable water use by NSF. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.
4. Pipe Flange, Fitting and Coupling Connection Applications: Unless otherwise noted, all pipe flange, fitting and coupling connection bolts shall be carbon steel per ASTM A307, Grade A hex bolts, with nuts per ASTM A563. All bolts, nuts and washers shall be zinc plated. Protect all threads on bolts and nuts with anti-seize lubricant.

a. Exposed Connections: For exposed pipe connections in buried vaults, manholes, and structures with forced-air ventilation and which drain through a gravity sewer or to a sump with a pump, prepare and coat bolts and nuts after installation with the same system as the adjacent flanged piping, in accordance with Section 09 90 00 – Painting and Coating.

b. Buried Connections: Coat all buried connections in accordance with Section 09 97 01 – Pipeline Coatings and Linings. Provide wax tape coating per AWWA C217 for steel pipe connections, including sleeve couplings and restrained sleeve couplings. For other pipe materials, grease and wrap connections per AWWA C105.

5. Bolt Requirements:
   a. The bolt and nut material shall be free-cutting steel.
   b. The nuts shall be capable of developing the full strength of the bolts.
   c. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads.
   d. Provide bolts with hexagon heads. Provide nuts conforming to Heavy Hexagon Series.
   e. Install all bolts and nuts with washers fabricated of material matching the base material of bolts, except that hardened washers for high strength bolts shall conform to the requirements of the AISC Specification.
   f. Install lock washers with washers where indicated and fabricated of material matching the bolts.

G. Provide bolts of length such that after joints are made up, each bolt shall extend through the entire nut, but in no case more than 1/2-inch beyond the nut.

H. Epoxy Anchors: Unless otherwise indicated, all drilled concrete or masonry anchors shall be epoxy anchors. No substitutions will be considered unless accompanied with ICC-ES reports verifying strength and material equivalency.
   1. Epoxy anchors are required for drilled anchors where exposed to weather, in submerged, wet, splash, overhead, and corrosive conditions, and for anchoring handrails, pumps, mechanical equipment, and reinforcing bars. Provide threaded stainless steel rod, Type 316.
   2. Unless otherwise indicated, epoxy anchors will also be permitted in locations not indicated above.
   3. Products for concrete anchorage:
      a. HIT-RE 500-V3, Hilti.
      b. HIT-HY 200, Hilti
      c. Set XP, Simpson Strong-Tie.
      d. Red Head C6+, ITW Ramset/Redhead.
      e. Engineer approved equal.
   4. Products for masonry anchorage:
      a. HIT-HY 270, Hilti.
      b. Set XP, Simpson Strong-Tie.
      c. Red Head C6+, ITW Ramset/Redhead.
      d. Engineer approved equal.

I. Expansion Anchors: Expansion anchors will only be permitted when specifically approved by the Engineer. Expansion anchors that are to be fully encased in grout may be carbon steel.

For non-encased buried or submerged anchors, provide stainless steel anchors. When expansion anchors are indicated or permitted, provide the following:

1. Kwik-Bolt TZ, Hilti.
2. Strong-Bolt 2, Simpson Strong-Tie.
3. Trubolt, ITW Ramset/Redhead.
4. Engineer approved equal.

J. Corrosion Protection:

1. Hot-dip galvanize all miscellaneous steel metalwork after fabrication.
    a. Galvanizing: ASTM A123 or A653 with minimum coating of 1.5 ounce per square foot.

2.3 MANUFACTURED UNITS

A. Handrails and Guardrails: Refer to Section 05 52 13 – Pipe and Tube Railings.

B. Bollards:

1. Standard weight steel pipe, diameter as shown on Drawings.
2. Minimum 48 inches projection above finish grade.
3. Minimum 42 inches embedment in concrete.
4. Fabricate sleeves for removable bollards from steel pipe with 1/4-inch thick steel plate welded to bottom of sleeve.

C. Abrasive Stair Nosings:

1. Extruded aluminum shape with cast-in abrasive strips and integral extruded anchors.
2. Material: Alloy 6063-T6 extruded aluminum, mill finish, heat treated.
3. Color to be selected by Engineer from manufacturer's standard colors.
4. Units: 3 inches wide by 4 inches less in length than stair tread width, centered on tread width.
5. Products:
    a. Style 231-A, American Abrasive Metals Company.
    b. 31-A American Mason Safety Tread Company.
    c. Supergrit Type 231, Wooster Products Company.
    d. Engineer approved equal.

D. Ladders:

1. Ladders shall be of stainless steel or galvanized steel as shown on the Contract Documents. When material is not specifically noted, material shall be stainless steel.
2. Design to support minimum 300-pound concentrated vertical load with 150-pound concentrated horizontal load.
    a. Maximum allowable stresses per AISC manual.
    b. Maximum lateral deflection: Side rail span/300.
    c. Design in accordance with OSHA standards.
3. Fabricate ladders for the locations shown, with dimensions, spacings, details, and anchorages as indicated. Comply with requirements of ANSI A14.3.
4. Side rails, minimum sizes: Continuous, 1 1/2-inch nominal diameter pipe. Fabricate with eased edges, spaced 18 inches apart.
5. Rungs: 1-1/8 inch by 1-5/8 inch by 14 gage perforated "traction tread" rungs.
    a. Top rung level with top platform.

6. Fit rungs in centerline of side rails, plug weld and grind smooth on outer rail faces.
7. Support each ladder at top and bottom and at intermediate points spaced not more than 4 feet on center with welded or bolted steel brackets.
8. Size brackets to support design dead and live loads indicated and to hold centerline of ladder rungs clear of the wall surface by not less than 9 inches.
9. When required by Drawings, every ladder that does not have an exterior handhold shall be equipped with a pop-up extension. Pop-up extension device shall be manufactured of the same material and finish as the ladder with telescoping tubular section that locks automatically when fully extended. Upward and downward improvement shall be controlled by stainless steel spring balancing mechanisms. Units shall be completely assembled with fasteners for securing to the ladder rungs in accordance with the manufacturer's instructions.

E. Metal Grating:
1. Metal grating shall be of the design, sizes, and types indicated. Completely band at all edges and cutouts using material and cross section equivalent to the bearing bars. Such banding shall be welded to each cut bearing bar. Support grating at bearings by support members. Where grating is supported on concrete, embedded support angles matching grating material shall be used unless indicated otherwise. Such angles shall be mitered and welded at corners.
2. Bearing Bars:
   a. Type: Rectangular bar.
   b. Thickness: 3/16 inch minimum.
   c. Depth: 1-1/2 inch unless otherwise indicated on Contract Documents.
   d. Spacing: 1 3/16 inch maximum.
   e. Configuration of top surface: Plain unless otherwise indicated on Contract Documents.
3. Cross Bars:
   a. Cross bars shall be welded or mechanically locked tightly into position so that there is no movement allowed between bearing and cross bars.
   b. Spacing: 4 inches maximum.
4. All pieces of grating shall be fastened in at least two locations to each support.
5. Where grating forms the landing at the top of a stairway, the edge of the grating, which forms the top riser, shall have an integral non-slip nosing, width equal to that of the stairway.
6. Where grating depth is not given, grating shall be provided which will be within allowable stress levels, and which shall not exceed a deflection of ¼-inch or the span divided by 180, whichever is less. For standard duty plank, and safety grating, the loading to be used for determining stresses and deflections shall be the uniform live load of the adjacent floor or 100 psf, whichever is greater or a concentrated moving load of 1000 pounds.
7. Material:
   a. Galvanized Steel: Except where indicated otherwise, bar grating shall be fabricated entirely of hot-dip galvanized carbon steel.
   b. Aluminum: Bearing and banding bars, alloy 6063-T5.
   c. Grating which may be partially or wholly submerged shall be fabricated entirely of stainless steel.
8. No single piece of grating shall weigh more than 80 pounds or be wider than 3 feet, unless indicated otherwise on Contract Documents.

F. Floor Hatches:
   1. Where floor access hatches are called for on the Contract Documents to be mounted on a floor slab (including top slabs which are not covered with a roofing membrane) or on a concrete curb, the hatch shall be a flush type as indicated herein.
   2. Material: Aluminum alloy 6061-T6 unless otherwise indicated. Provide Type 316 stainless steel hardware.
   3. Design Live Load: Minimum 300 psf.
   4. Provide hatch opening sizes, number and directional swing of door leaves, and locations as indicated on the Drawings. Sizes given are for the clear opening. Where the number of leaves is not indicated, provide double-leaf doors for openings larger than 42 inches in either direction. Unless indicated otherwise, locate hinges on the longer dimension side. Unless indicated otherwise, ladder hatches shall be a minimum of 30 inches wide by 36 inches long, with the ladder centered on the shorter dimension and the door hinge opposite the ladder.
   5. Hatch shall have oversized recessed padlock clipe that can accommodate a lock with a 2.5" shackle length.
   6. Hatch shall be equipped with recesses safety grating for fall protection.
   7. Door leaves shall be a minimum of 1/4-inch checkered pattern plate. Channel frames shall be a minimum of 1/4-inch material with an anchor flange around the perimeter. Hatches shall be provided with an automatic hold-open arm with release handle. Hatches shall be designed for easy opening from both inside and outside.
   8. Aluminum surfaces in contact with other metals or concrete shall be painted for aluminum metal isolation. Caulk the mounting flange of access hatches for water tightness when mounted to concrete curbs.
   9. Products:
      a. Type "APS" or "APD," Babcock Davis Associates.
      b. Type "J" or "JD", Bilco.
      c. Type "SLG" or "DLG," Dur-Red Products.
      d. Engineer approved equal.

G. Roof Hatches:
   1. Where indicated on Contract Drawings, hatches mounted on a roof surface of whatever material shall be the integral raised curb type as indicated in Section 07 72 00 – Roof Accessories.

H. Iron Castings:
   1. Iron castings shall be of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects. They shall be smooth and well cleaned by shot blasting. Castings shall be prefabricated, conforming to ASTM A48 or A536.
   2. Covers and grates shall fit together evenly, so that the cover fits flush with the surrounding finished surface and so that the cover does not rock or rattle when loading is applied. Round covers and frames shall have machined bearing surfaces.
   3. Covers and grates with matching frames shall be designed to support the following loadings:
      a. Where located within a structure, the design loading shall match that required for the adjacent floor area, or, if no floor loading is given, a minimum of 300 pounds per square foot.
      b. Exterior covers and grates shall be designed for AASHTO HS-20 loading unless indicated otherwise.

I. All Purpose Metal Framing:
   1. Material: Carbon Steel.
   2. Channels and inserts:
      a. Minimum 12 gage.
      b. Channels to have one side with a continuous slot and inturned lips.
   3. Fittings: Hot-rolled steel strip and plate.
   4. Nuts: Steel, ASTM A563, with toothed grooves in top of nuts to engage the inturned lips of channels.
   5. Finish: Epoxy coated. Galvanize items which cannot be epoxy coated.

2.4 FABRICATION

A. Verify field conditions and dimensions prior to fabrication.

B. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.

C. Form exposed work true to line and level with accurate angles and surfaces straight and sharp edges.

D. Drill and punch holes with smooth edges.

E. Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.
   1. Temperature Range: 0 degrees F minimum to 110 degrees F maximum ambient temperature.

F. Shear and punch metals cleanly and accurately. Remove burrs.

G. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

H. Remove sharp or rough areas on exposed traffic surfaces.

I. Welding
   1. Welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.
   2. In assembly and during welding, the component parts shall be adequately clamped, supported and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as indicated by the AWS Code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours

and dimensions. All sharp corners of material that are to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

3. Weld corners and seams continuously to comply with the following:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
   d. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.

J. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners whenever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

K. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

L. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

M. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

N. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.5 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of the required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Hot-dip galvanize after fabrication.

2.6 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel studs for embedding into concrete.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

A. Provide steel framing and supports for applications indicated that are not a part of structural steel framework as required to complete the Work.

B. Fabricate units to sizes, shapes, and profiles indicated and required to receive other adjacent construction retained by framing and supports.

C. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection.

D. Cut, drill, and tap units to receive hardware, hangers, and similar items.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

B. Inspect and verify condition of substrate. Correct any surface defects or conditions which might interfere with or prevent a satisfactory installation.

C. Set sleeves in concrete with tops flush with finish surface elevations. Protect sleeves from water and concrete entry.

3.2 INSTALLATION

A. Set metal work level, true to line, plumb.

B. In fabrication and erection of structural steel, conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."

C. Shim and grout as necessary.

D. To the maximum extent possible, use bolted field connections. Where practicable, conceal the fastenings. When field welding is warranted, comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish/grind exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.

E. Unless notes or specified otherwise:
   1. Connect steel members to steel members with 3/4-inch diameter high strength bolts.
   2. Connect aluminum to aluminum with 3/4-inch diameter aluminum bolts.
   3. Connect aluminum to structural steel using 3/4-inch diameter stainless steel bolts.
   4. Connect aluminum and steel members to concrete and masonry using 3/4-inch stainless steel epoxy anchors. Provide a minimum of 5 1/2 inches of embedment into concrete or masonry.

F. Do not field splice fabricated items unless said items exceed standard shipping length or change of direction requires splicing. Provide fully welded splices where continuity is required.

G. Provide each fabricated item complete with attachment devices as indicated or required to install.

H. Anchor metal items so that items will not be distorted nor fasteners overstressed from expansion and contraction.

I. Install bollards in concrete as detailed. Fill pipe with concrete and round off at top of pipe.

J. Center abrasive stair nosings in stair.

K. Attach grating to end and intermediate supports with grating saddle clips and bolts.
   1. Maximum spacing: 2 feet on center with a minimum of two attachments per support.
   2. Attach individual units of grating together with clips or attachments at 2 feet on center maximum with a minimum of two clips per side.

L. Coat ferrous metals in accordance with Section 09 90 00 – Painting and Coating.

M. Coat surfaces of aluminum that will come in contact with grout, concrete, masonry, wood or dissimilar metals with the following:
   1. Cast Aluminum: Heavy coat of bituminous paint.
   2. Extruded Aluminum: Two coats of clear lacquer.

3.3 DRILLED ANCHORS

A. Drilled-in anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions. Holes shall be roughened with a brush on a power drill, cleaned and dried. Drilled anchors shall not be installed until the concrete has reached the specified 28-day compressive strength. Epoxy anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

3.4 SETTING LOOSE PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.

B. Set loose level and bearing plates on wedges or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the bearing plate before packing with grout.
   1. Use non-shrink grout in concealed locations where not exposed to moisture.
   2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop painted surfaces.
   1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780

END OF SECTION

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SECTION 05 51 13
METAL PAN STAIRS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Preassembled steel stairs with concrete-filled treads.
2. Steel tube railings attached to metal stairs.
3. Steel tube handrails attached to walls adjacent to metal stairs.

B. Related Requirements:
1. Section 03 30 00 - Cast-in-Place Concrete for concrete fill for stair treads and platforms.
2. Section 05 52 00 - Pipe and Tube Railings for pipe and tube railings.
3. Section 09 90 01 - Protective Coatings
4. Section 09 91 23 - Interior Paint

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Coordinate locations of hanger rods and struts with other work so that they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.

1.4 ACTION SUBMITTALS

A. Product Data: For metal pan stairs and the following:
1. Paint products.

B. Sustainable Design Submittals:
1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

D. Delegated-Design Submittal: For stairs and railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Alfab, Inc.
2. American Stair, Inc.
3. Lapeyre Stair Inc.
4. Pacific Stair Corporation.
5. Worthington Metal Fabricators.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 45 00 – Quality Control to design stairs and railings.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Uniform Load: 100 lbf/sq. ft. (4.79 kN/sq. m).
2. Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in. (2580 sq. mm).
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch (6.4 mm), whichever is less.

C. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ft. (0.73 kN/m) applied in any direction.
b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:
a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
b. Infill load and other loads need not be assumed to act concurrently.

D. Seismic Performance of Stairs: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. Component Importance Factor: 1.5.

2.3 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513.

2.4 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for.

D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy **Group 1 (A1)** or **Group 2 (A4)** stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.5 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 09 91 13 - Exterior Painting and Section 09 91 23 - Interior Painting.

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
   1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

F. Concrete Materials and Properties: Comply with requirements in Section 03 30 00 - Cast-in-Place Concrete for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa) unless otherwise indicated.

G. Nonslip-Aggregate Concrete Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.

H. Welded Wire Reinforcement: ASTM A 185/A 185M, 6 by 6 inches (152 by 152 mm), W1.4 by W1.4, unless otherwise indicated.

2.6 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
   1. Join components by welding unless otherwise indicated.
   2. Use connections that maintain structural value of joined pieces.

B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Weld exposed corners and seams continuously unless otherwise indicated.
   5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 3 welds: partially dressed weld with spatter removed.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

2.7 STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," Commercial Class, unless more stringent requirements are indicated.

B. Stair Framing:
   1. Fabricate stringers of steel plates or channels.
      a. Provide closures for exposed ends of channel stringers.
   2. Construct platforms of steel plate or channel headers and miscellaneous framing members as needed to comply with performance requirements indicated.
   3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
   4. Where stairs are enclosed by gypsum board shaft-wall assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.
   5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

C. Metal Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements, but not less than 0.067 inch (1.7 mm).
   1. Steel Sheet: Uncoated cold-rolled steel sheet unless otherwise indicated.
   2. Directly weld metal pans to stringers; locate welds on top of subtreads where they are concealed by concrete fill. Do not weld risers to stringers.
   3. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
   4. Shape metal pans to include nosing integral with riser.
   5. Attach abrasive nosings to risers.
   6. At Contractor's option, provide stair assemblies with metal pan subtreads filled with reinforced concrete during fabrication.

7. Provide epoxy-resin-filled treads, reinforced with glass fibers, with slip-resistant, abrasive surface.
8. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.
    a. Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.

2.8 STAIR RAILINGS

A. Comply with applicable requirements in Section 05 52 00 - Pipe and Tube Railings.
1. Fabricate newels of square steel tubing and provide newel caps of pressed steel or gray-iron castings.
2. Connect posts to stair framing by direct welding unless otherwise indicated.

B. Welded Connections: Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
1. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint as shown in NAAMM AMP 521.

C. Form changes in direction of railings as follows:
1. As detailed.
2. By bending or by inserting prefabricated elbow fittings.
3. By flush bends or by inserting prefabricated flush-elbow fittings.
4. By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.
5. By inserting prefabricated elbow fittings flush-elbow fittings elbow fittings of radius indicated.

D. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

E. Close exposed ends of railing members with prefabricated end fittings.

F. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.

G. Connect posts to stair framing by direct welding unless otherwise indicated.

H. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
1. For galvanized railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
2. For nongalvanized railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.

3. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch (38-mm) clearance from inside face of handrail to finished wall surface.

I. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.9 FINISHES

A. Finish metal stairs after assembly.

B. Galvanizing: Hot-dipped galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."

D. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLING METAL PAN STAIRS

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size

limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dipped galvanized after fabrication and are for bolted or screwed field connections.

F. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

G. Place and finish concrete fill for treads and platforms to comply with Section 03 30 00 - Cast-in-Place Concrete.
   1. Install abrasive nosings with anchors fully embedded in concrete. Center nosings on tread width.

H. Install precast concrete treads with adhesive supplied by manufacturer.

3.2 INSTALLING RAILINGS

A. Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:
   1. Anchor posts to steel by welding or bolting to steel supporting members.
   2. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with post installed anchors and bolts.

B. Attach handrails to wall with wall brackets. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as required to comply with performance requirements.
   1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
   2. For hollow masonry anchorage, use toggle bolts.
   3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
   4. For steel-framed partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with stud installation to locate backing members.
   5. For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
   6. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 91 13 - Exterior Painting and Section 09 91 23 - Interior Painting.

END OF SECTION

SECTION 05 52 00
PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Shop primed steel pipe and tube handrails and guardrails.

B. Related Sections include the following:
   1. Division 06 Section "Rough Carpentry" for wood blocking for anchoring railings.

1.3 PERFORMANCE REQUIREMENTS

A. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
   1. Steel: 72 percent of minimum yield strength.

B. Structural Performance: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   1. Handrails and guardrails:
      a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
      b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   2. Top Rails of Guards:
      a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
      b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   3. Infill of Guards:
      a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
      b. Infill load and other loads need not be assumed to act concurrently.

C. Thermal Movements: Provide exterior railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Manufacturer's product lines of mechanically connected railings.
   2. Grout, anchoring cement, and paint products.

B. Leed Submittal Requirements
   1. Product Data for Credit MR 4.0: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content.
   2. Product Data for Credit MR 5.0: Product data indicating location of material manufacturer for regionally manufactured materials. Include statement indicating cost for each regionally manufactured material and for each regionally extracted and manufactured material.

      Include statement indicating distance from manufacturer to Project for each regionally manufactured material.
      a. Include statement indicating location of and distance from Project to point of extraction, harvest, or recovery for each raw material used in regionally extracted and manufactured materials.
      b. Include statement indicating costs for each product having regional content.
   3. Product Data for Credit EQ 4.2: Product data for paints and coatings used inside the weatherproofing system indicating chemical composition and VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      a. Include statement indicating manufacturer's name, product name, and specific VOC data (in g/L, less water) for each product.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Welding certificates.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of railing through one source from a single manufacturer.

B. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.
   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating railings without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
   2. Provide allowance for trimming and fitting at site.

1.7 COORDINATION AND SCHEDULING

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Steel Pipe and Tube Railings:
      a. Pisor Industries, Inc.
      b. Sharpe Products.
      c. Wagner, R & B, Inc.; a division of the Wagner Companies.
      d. Others meeting performance requirements.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

2.3 STEEL AND IRON

A. Tubing: ASTM A 500 (cold formed) or ASTM A 513, Type 5 (mandrel drawn).

B. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Provide galvanized finish for exterior installations and where indicated.

C. Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.4 FASTENERS

A. General: Provide the following:
1. Steel Railings: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:
1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.

D. Anchors: Provide cast-in-place, chemical, or torque-controlled expansion anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

D. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
1. Water-Resistant Product: At exterior locations and where indicated provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with welded connections, unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove flux immediately.
   4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
   1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

J. Form changes in direction as follows:
   1. By bending or by inserting prefabricated elbow fittings.

K. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

L. Close exposed ends of railing members with prefabricated end fittings.

M. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.

N. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work, unless otherwise indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide fillers made from crush-resistant material, or other means to transfer wall loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

O. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure. Us only corrosion-resistant materials.

P. For railing posts set in concrete, provide corrosion-resistant sleeves not less than 6 inches (150 mm) long with inside dimensions not less than 1/2 inch (13 mm) greater than outside dimensions of post, with steel plate forming bottom closure.

Q. For removable railing posts, fabricate slip-fit sockets from stainless-steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.
1. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

R. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.8 STEEL AND IRON FINISHES

A. Galvanized Railings:
1. Hot-dip galvanize exterior steel and iron railings, including hardware, after fabrication.
2. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.

B. Fill vent and drain holes that will be exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

C. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
   1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
   2. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
   3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (5 mm in 3 m).

C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches (50 mm) beyond joint on either side, fasten internal sleeve securely to 1 side, and locate joint within 6 inches (150 mm) of post.

3.4 ANCHORING POSTS

A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Form or core-drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

C. Leave anchorage joint exposed; wipe off surplus anchoring material; and leave 1/8-inch (3-mm) buildup, sloped away from post.

D. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.5 ATTACHING HANDRAILS TO WALLS

A. Attach handrails to wall with wall brackets. Provide brackets with 1-1/2-inch (38-mm) clearance from inside face of handrail and finished wall surface.
   1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
   2. Use type of bracket with predrilled hole for exposed bolt anchorage.

B. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

C. Secure wall brackets to building construction as follows:
   1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
   2. For hollow masonry anchorage, use toggle bolts.
   3. For wood stud partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with carpentry work to locate backing members.
   4. For steel-framed gypsum board partitions, use hanger or lag bolts set into fire-retardant-treated wood backing between studs. Coordinate with stud installation to locate backing members.

3.6 ADJUSTING AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.7 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION

DIVISION 06
WOOD, PLASTICS, AND COMPOSITES

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SECTION 06 10 53
MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Framing with dimension lumber.
2. Rooftop equipment bases and support curbs.
3. Wood blocking and nailers.
4. Utility shelving.
5. Plywood backing panels.

1.3 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal (38 mm actual) size in least dimension.

B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater size but less than 5 inches nominal (114 mm actual) size in least dimension.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
3. Chain-of-Custody Qualification Data: For manufacturer and vendor.
4. Product Data: For installation adhesives, indicating VOC content.
5. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:
1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.
4. Post-installed anchors.
5. Metal framing anchors.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

B. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Regional Materials: Dimension lumber, except treated materials, shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. “Regional Materials" Paragraph below applies to LEED 2009 CI Credit MR 5, Option 1.

B. Certified Wood: Lumber and plywood shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-00 and FSC STD-40-004.

C. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   1. Factory mark each piece of lumber with grade stamp of grading agency.
   2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
   3. Dress lumber, S4S, unless otherwise indicated.

D. Maximum Moisture Content of Lumber: 15 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2.
   1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
   2. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings, and the following:
   1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
   3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
   4. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
   5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 DIMENSION LUMBER FRAMING

A. Other Framing: No. 2 grade of the following species:
   1. Hem-fir (north); NLGA.
   2. Southern pine; SPIB.
   3. Douglas fir-larch; WCLIB or WWPA.
   4. Spruce-pine-fir; NLGA.
   5. Douglas fir-south; WWPA.
   6. Hem-fir; WCLIB or WWPA.

7. Douglas fir-larch (north); NLGA.
8. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.
4. Cants.
5. Furring.
6. Grounds.
7. Utility shelving.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any of the following species:
1. Hem-fir (north); NLGA.
2. Mixed southern pine or southern pine; SPIB.
3. Spruce-pine-fir; NLGA.
4. Hem-fir; WCLIB or WWPA.
5. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
6. Western woods; WCLIB or WWPA.
7. Northern species; NLGA.

C. Utility Shelving: Lumber with 15 percent maximum moisture content of any of the following species and grades:
1. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Premium or No. 2 Common (Sterling) grade; NeLMA, NLGA, WCLIB, or WWPA.
2. Mixed southern pine or southern pine No. 1 grade; SPIB.
3. Hem-fir or hem-fir (north), Select Merchantable or No. 1 Common grade; NLGA, WCLIB, or WWPA.
4. Spruce-pine-fir (south) or spruce-pine-fir, Select Merchantable or No. 1 Common grade; NeLMA, NLGA, WCLIB, or WWPA.

D. Concealed Boards: 15 percent maximum moisture content of any of the following species and grades:
1. Mixed southern pine or southern pine, No. 2 grade; SPIB.
2. Hem-fir or hem-fir (north), Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
3. Spruce-pine-fir (south) or spruce-pine-fir, Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
4. Northern species, No. 2 Common grade; NLGA.
5. Western woods, Construction or No. 2 Common grade; WCLIB or WWPA.

E. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

F. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

G. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than **3/4-inch (19-mm)** nominal thickness.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Screws for Fastening to Metal Framing: ASTM C 1002, length as recommended by screw manufacturer for material being fastened.

D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 ICC-ES AC58 or ICC-ES AC308 as appropriate for the substrate.
   1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
   2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

2.7 METAL FRAMING ANCHORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cleveland Steel Specialty Co.
   2. KC Metals Products, Inc.
   3. Phoenix Metal Products, Inc.
   4. Simpson Strong-Tie Co., Inc.
   5. USP Structural Connectors.

B. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
   1. Use for interior locations unless otherwise indicated.

C. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 (Z550) coating designation; and not less than 0.036 inch (0.9 mm) thick.
   1. Use for wood-preservative-treated lumber and where indicated.

2.8 MISCELLANEOUS MATERIALS

A. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
   1. Adhesives shall have a VOC content of 70 g/L or less.

B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.

C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

D. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

E. Do not splice structural members between supports unless otherwise indicated.

F. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
   1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.

G. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:

   1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.

2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches (2438 mm) o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal (38-mm actual) thickness.
3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. (9.3 sq. m) and to solidly fill space below partitions.
4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet (6 m) o.c.

H. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

I. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

J. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

K. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
3. ICC-ES evaluation report for fastener.

L. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD BLOCKING AND NAILER INSTALLATION

A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 06 40 23
INTERIOR ARCHITECTURAL WOODWORK

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Interior standing and running trim.
   2. Plastic-laminate cabinets.
   3. Solid surfacing material countertops and windowsills.

B. Related Sections include the following:
   1. Division 6 Section "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.

1.3 DEFINITIONS

A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, including cabinet hardware and accessories.

B. Product Data: For high-pressure decorative laminate, adhesive for bonding plastic laminate, fire- retardant-treated materials, cabinet hardware and accessories, and finishing materials and processes.
   1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
   1. Show details full size.
   2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.

3. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, and other items installed in architectural woodwork.
4. Apply WI-certified compliance label to first page of Shop Drawings.

D. Samples for Initial Selection:
1. Plastic laminates.
2. PVC edge material.
3. Solid surfacing material.

E. Samples for Verification:
1. Exposed cabinet hardware and accessories, one unit for each type and finish.

F. Product Certificates: For each type of product, signed by product manufacturer.

G. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

H. Qualification Data: For fabricator.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service
performance. Shop is a certified participant in AWI's Quality Certification Program.

B. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.
1. Provide AWI Quality Certification Program labels and certificates indicating that woodwork, including installation, complies with requirements of grades specified.

C. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored

in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period. Alternately, warrant completed installation to meet specified levels of moisture and shrinkage cracking.

B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.8 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

B. Hardware Coordination: Distribute copies of approved hardware schedule specified in Division 8 Section "Door Hardware" to fabricator of architectural woodwork; coordinate Shop Drawings and fabrication with hardware requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Wood Products: Comply with the following:

1. Hardboard: AHA A135.4.
2. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.
3. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.
4. Softwood Plywood: DOC PS 1.

5. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no urea formaldehyde.

B. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
1. Manufacturer: Subject to compliance with requirements, manufacturers whose products can be incorporated into the work include, but are not limited to the following:
a. Formica Corporation.
b. United Decorative Plastics
c. Wilsonart International; Div. of Premark International, Inc.

C. Solid Surfacing material: Homogeneous solid sheets of filled plastic resin complying with ISSFA- 2.
1. Manufacturer: Subject to compliance with requirements, manufacturers whose products can be incorporated into the work include, but are not limited to the following:
a. ABA Industries.
b. Avonite, Inc.
c. DuPont Surfaces.
d. Formica Corporation.
e. LG Chemical, Ltd.
f. Meganite Inc.; a division of the Pyrochem Group.
g. Samsung Chemical USA, Inc. Staron Division
h. Swan Corporation (The).
i. Transolid, Inc.
j. Wilsonart International; Div. of Premark International, Inc.

2.2 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this Article, which are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified.
1. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use the following treatment type:

1. Exterior Type: Organic-resin-based formulation thermally set in wood by kiln drying.
2. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test- response characteristics, using a woodworking plant certified by testing and inspecting agency.
3. Kiln-dry materials before and after treatment to levels required for untreated materials.

C. Fire-Retardant Particleboard: Panels complying with the following requirements, made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame- spread index of 25 or less and smoke-developed index of 25 or less per ASTM E 84.
1. For panels 3/4 inch (19 mm) thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi (11 MPa); modulus of elasticity, 300,000 psi (2070 MPa); internal bond, 80 psi (550 kPa); and screw-holding capacity on face and edge, 250 and 225 lbf (1100 and 1000 N), respectively.
2. For panels 13/16 to 1-1/4 inches (20 to 32 mm) thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, 1300 psi (9 MPa); modulus of elasticity, 250,000 psi (1720 MPa); linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 250 and 175 lbf (1100 and 780 N), respectively.
3. Product: Subject to compliance with requirements, provide "Duraflake FR" by Weyerhaeuser.

D. Fire-Retardant Fiberboard: Medium-density fiberboard panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E 84.
1. Product: Subject to compliance with requirements, provide "Medite FR" by SierraPine Ltd.; Medite Div.

2.3 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 8 Section "Door Hardware."

B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 170 degrees of opening, self- closing.

C. Wire Pulls: Back mounted, solid metal, 5 inches (127 mm) long, 2-1/2 inches (63.5 mm) deep, and 5/16 inch (8 mm) in diameter.

D. Catches: Magnetic catches, BHMA A156.9, B03141.

E. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.

F. Shelf Rests: BHMA A156.9, B04013; metal.

G. Drawer Slides: BHMA A156.9, B05091.

1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc- plated steel ball-bearing slides.
2. Box Drawer Slides: Grade 1HD-100; for drawers not more than 6 inches (150 mm) high and 24 inches (600 mm) wide.

H. Door Locks: BHMA A156.11, E07121.

I. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.

1. Satin Stainless Steel: BHMA 630.

J. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.4 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

C. Adhesives, General: Do not use adhesives that contain urea formaldehyde.

D. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Wood Glues: 30 g/L.
2. Contact Adhesive: 250 g/L.

E. Adhesive for Bonding Plastic Laminate: Un-pigmented contact cement.

1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

2.5 FABRICATION, GENERAL

A. Interior Woodwork Grade: Unless otherwise indicated, provide Custom-grade interior woodwork complying with referenced quality standard.

B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

C. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

D. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
   1. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members 3/4 Inch (19 mm) Thick or Less: 1/16 inch (1.5 mm).
   2. Edges of Rails and Similar Members More Than 3/4 Inch (19 mm) Thick: 1/8 inch (3 mm).
   3. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members and Rails: 1/16 inch (1.5 mm).

E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
   1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.

F. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
   1. Seal edges of openings in countertops with a coat of varnish.

2.6 INTERIOR STANDING AND RUNNING TRIM FOR OPAQUE FINISH

A. Grade: Custom.

B. Wood Species: Any closed-grain hardwood.

2.7 PLASTIC-LAMINATE CABINETS

A. Grade: Custom.

B. AWI Type of Cabinet Construction: Flush overlay.

C. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
   1. Horizontal Surfaces Other Than Tops: Grade HGS.
   2. Post-formed Surfaces: Grade HGP.
   3. Vertical Surfaces: Grade HGS.
   4. Edges: Grade HGS.

D. Materials for Semi exposed Surfaces:
   1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, Grade VGS.
      a. Edges of Plastic-Laminate Shelves: PVC T-mold matching laminate in color, pattern, and finish.
      b. For semi exposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, Grade VGS.
   2. Drawer Sides and Backs: Solid-hardwood lumber.
   3. Drawer Bottoms: Hardwood plywood.

E. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKL.

F. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
   1. As selected by Architect from laminate manufacturer's full range in the following categories:
      a. Solid colors with core same color as surface, matte finish.

G. Provide dust panels of 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

2.8 SHOP FINISHING

A. Grade: Provide finishes of same grades as items to be finished.

B. General: Finish architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.

C. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.
   1. Back priming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require back priming when surfaced with plastic laminate, backing paper, or thermoset decorative panels.

D. Opaque Finish:

1. Grade: Custom.
2. AWI Finish System: Catalyzed lacquer.
3. Color: As selected by Architect from manufacturer's full range.
4. Sheen: Semi-gloss, 46-60 gloss units measured on 60-degree gloss meter per ASTMD 523.

PART 3 – EXECUTION

3.1 PREPARATION

A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.

B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and back priming.

3.2 INSTALLATION

A. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.

B. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).

C. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

D. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.

E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

F. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 96 inches (2400 mm) long except where shorter single-length pieces are necessary.
1. Scarf running joints and stagger in adjacent and related members.
2. Fill gaps, if any, between top of base and wall with latex sealant, painted to match wall.

3. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches (3 mm in 2400 mm).

G. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
   1. Install cabinets with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
   2. Maintain veneer sequence matching of cabinets with transparent finish.
   3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches (400 mm) o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.

H. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
   1. Install countertops with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
   2. Secure backsplashes to tops with concealed metal brackets at 16 inches (400 mm) o.c. and to walls with adhesive.
   3. Calk space between backsplash and wall with sealant specified in Division 7 Section "Joint Sealants."

I. Windowsills: Permanently attach with low-VOC construction adhesive.

J. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

K. Refer to Division 9 Sections for final finishing of installed architectural woodwork not indicated to be shop finished.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
B. Clean, lubricate, and adjust hardware.
C. Clean woodwork on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION

SECTION 06 60 00
FIBERGLASS REINFORCED PLASTIC FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install fiberglass reinforced plastic fabrications, complete and serviceable as shown on the Drawings and as specified herein.

B. Section Includes:
1. Structural shapes.
2. Grating.
3. Grating floor system.
4. Stair treads.
5. Fixed ladders.
6. Railing.
7. Weir troughs.
8. Weir plates.
9. Baffle walls and chimneys.
10. Stop logs.

1.2 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM A666	Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTM D256	Standard Test Methods for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics
ASTM D570	Standard Test Method for Water Absorption of Plastics
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D695	Standard Test Method for Compressive Properties of Rigid Plastics
ASTM D696	Standard Test Method for Coefficient for Coefficient of Linear Thermal Expansion of Plastics Between -30 Degrees C and 30 Degrees C with a Vitreous Silica Dilatometer
ASTM D790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

ASTM D2344	Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates
ASTM D2583	Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
ASTM E84	Surface Burning Characteristics of Building Material

B. American Water Works Association (AWWA) standards, most recent editions:

AWWA F101	Contact-Molded, Fiberglass-Reinforced Plastic Wash-Water Troughs and Launders
AWWA F102	Matched Die Molded, Fiberglass Reinforced Plastic Weir Plates, Scum Baffles, & Mounting Brackets

C. National Sanitation Foundation (NSF), most recent edition:

NSF 61	Drinking Water System Components, Health Effects

D. Occupational Safety and Health Administration (OSHA), most recent editions:

OSHA 1910.27	Fixed Ladders

1.3 DEFINITIONS

A. FRP: Fiberglass reinforced plastic.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 –Submittal Procedures.

B. Product Data: Submit manufacturer's published literature including material specifications, structural design data, structural properties and load and deflection tables for each style and type of fabrication used, corrosion resistance tables and anchoring systems and allowable load tables as applicable.

C. Shop Drawings: Submit shop drawings of all FRP fabrications and accessories.
   1. For grating, show direction of span, type and depth of grating, size and shape of individual panels, seat angle details, and details of grating clip fasteners.

D. Structural Calculations: Provide design calculations for items and systems not sized or designed in the Contract Documents.

E. Samples: The Engineer may require sample pieces of any item specified herein for acceptance as to quality and color. When required, submit samples manufactured by the method to be used in the Work.

F. Certified Test Reports: Provide when requested by Engineer.

G. Stop Log Leak Test: Provide results of stop-log leak tests to Engineer.

H. Qualification Statements: Provide qualification documents for manufacturer's experience history.

I. Warranty Documentation: Provide certificate of warrantees specified herein.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer having a minimum of 10 years' experience in design and manufacture of similar products and systems to those specified herein. When requested, provide evidence of at least 5 previous successful installations in the past 5 years.

B. Maintain a continuous quality control program and provide Engineer with certified test reports of physical tests on samples when requested.

C. Provide only new FRP material for the fabrications specified.

D. Licensed Professional Engineer: When design calculations are required, they must be signed and sealed by an engineer licensed to practice in the state of Utah.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Delivery and Acceptance Requirements: Deliver manufactured materials in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Package adhesives, resins, and their catalysts and hardeners separately and not such to facilitate movement to a dry indoor storage area.

C. Storage and Handling Requirements: Store all materials carefully to prevent them from damage. Store adhesives, resins, and their catalysts in dry indoor facilities between 70 degrees F and 85 degrees F until they are required.

1.7 WARRANTY

A. Provide manufacturer's written 3-year warranty on all FRP products against defects in materials and workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable.
   1. Grating and Treads
      a. Fibergrate Composite Structures, Inc. (Safe-T-Span).
      b. CorGrate Fiberglass Systems (CorGrate FW).
      c. Strongwell (Duradek).

d. Engineer approved equal.

2. Grating Floor System
   a. American Grating LLC.
   b. Fibergrate Composite Structures, Inc.
   c. Engineer approved equal.
3. Fixed Ladders
   a. CorGrate Fiberglass Systems.
   b. Fibergrate Composite Structures, Inc. (Dynarail)
   c. Strongwell.
   d. Engineer approved equal.
4. Railing
   a. CorGrate Fiberglass Systems.
   b. Fibergrate Composite Structures, Inc. (Dynarail)
   c. Strongwell.
   d. Engineer approved equal.

2.2 GENERAL

A. FRP items shall be composed of fiberglass reinforcement and resin in quantities, qualities, properties, arrangements, and dimensions as necessary to meet the design requirements and dimensions indicated.

B. Provide FRP products with tested flame spread rating of 25 or less per ASTM E84.

C. Resins for FRP products shall be vinyl ester with chemical formulation necessary to provide the corrosion resistance, strength, and other physical properties as required.

D. Finish
   1. Provide all finished surfaces of fiberglass items and fabrications smooth, resin-rich, free of voids, and without dry spots, crazes, or unreinforced areas.
   2. Provide for corrosion resistance and weathering.
   3. Outer surfaces with no glass fibers exposed.

E. Supports and Fasteners: Provide all bolts, anchor bolts, washers, nuts, and supports as required for FRP items specified in this Section, in accordance with the requirements of the manufacturers of the FRP items.
   1. Unless specified otherwise, provide connectors of [Hastelloy G-30] [Type 316 stainless steel].

F. Include an ultraviolet (UV) inhibitor in all FRP items. Additionally, provide an extra 1-mil UV coating on all FRP products located in exterior locations, exposed to the weather, or in UV facilities.

G. Design and install fiberglass items providing accommodation for expansion and contraction. Prevent shearing of bolts, screws, and other fastenings, and provide close fitting of sections. Design joints exposed to weather to exclude water.

H. Fabricate FRP products free from warps, twists, or other defects with affect appearance and serviceability.

2.3 STRUCTURAL SHAPES

A. Manufacture all structural shapes by the pultrusion process with a glass content minimum of 45 percent and a maximum of 55 percent by weight.

B. Minimum longitudinal mechanical properties are as follows.

Property	ASTM Method	Minimum Value	Units
Tensile Strength	D638	30,000	psi
Tensile Modulus	D638	2.5×10^6	psi
Flexural Strength	D790	30,000	psi
Flexural Modulus	D790	1.8×10^6	psi
Short Beam Shear	D2344	4,500	psi
Shear Modulus	N/A	4.5×10^5	psi
Coefficient of Thermal Expansion	D696	4.4×10^{-6}	In/in/deg F

2.4 GRATING

A. Furnish and install FRP grating in areas shown on the Drawings, including FRP angle supports and embeds, fasteners, and accessories.

B. Manufacture
1. Depth: As shown on Drawings.
2. Bearing bars and cross-rods manufactured by the pultrusion process having a maximum of 70 percent and a minimum of 60 percent continuous glass content (by weight).
3. Interlock bearing bars and bond to cross-rods to provide a panel that resists twisting forces and prevents internal movement of the bearing bars.
4. Non-slip Surface: Provide grating with quartz grit bonded and baked to the top surface of the finished grating product.
5. Color: Yellow

C. Load/Deflection Requirements: Provide grating capable of spanning the distances indicated without exceeding a deflection of span divided by 240 or 3/8 inch maximum when loaded at 100 psf.

D. Penetrations: Provide cutouts where needed for utility penetrations through the grating. Reinforce around such cutouts where necessary to meet the load/deflection requirements.

E. Fabricate individual grating panels into easily removable sections as large as possible up to 80 pounds.

F. Grating Clips: Install mechanical grating clips manufactured from Type 316 stainless steel and coated with epoxy coating. Provide a minimum of 4 clips per panel at a maximum of 4 feet on center.

2.5 GRATING FLOOR SYSTEM

A. Provide grating floor system in areas shown on the Drawings. Include all FRP angle supports, FRP adjustable pedestal supports, FRP cross bracing, fasteners, and accessories as required for a complete system. Provide products from a single manufacturer.

B. Manufacture
   1. Depth: As shown on Drawings.
   2. Design: Bidirectional molded FRP grating.
   3. Live Load: 100 psf, deflection limited to 1/4 inch
   4. Non-slip Surface: Provide grating with quartz grit bonded and baked to the top surface of the finished grating product.
   5. Color: Yellow

C. Fabricate individual grating panels into easily removable sections as large as possible up to 80 pounds.

D. Grating Clips: Install mechanical grating clips manufactured from Type 316 stainless steel and coated with epoxy coating. Fasteners shall not project above the walking surface.

2.6 STAIR TREADS

A. Furnish and install stair treads of one-piece construction reinforced with continuous rovings.

B. Non-slip Surface: Provide grating with quartz grit bonded and baked to the top surface of the finished grating product. Include 1-1/2 inch molded nosing to be bonded with angular grit.

C. Load/Deflection Requirements: Furnish stair treads with allowable stress levels and with deflection not to exceed 1/4 inch or the span length divided by 240, whichever is less. The loadings to be used for determining stresses and deflections are a uniform load of 100 psf or a concentrated load of 300 pounds located at center span.

2.7 FIXED LADDERS

A. Furnish and install FRP fixed ladder systems with all safety cages, landings, mounting clips, fasteners, and necessary appurtenances as shown on the Drawings.

B. Design Criteria
   1. Conform to OSHA requirements.
   2. Design to support a 1200-pound load applied at any point.

C. Fabricate side rails from square tube, minimum 2 inches square (nominal) by 1/4 inch thick. Anchor with FRP standoff clips manufactured of vinyl ester resin. Place clips as shown on the Drawings at maximum spacing of 4 feet.

D. Rungs
   1. Uniformly spaced at 12 inches maximum
   2. Attach to rails by both mechanical attachment and epoxy bond.

E. When required, furnish and install fall prevention system and anti-climb guards in accordance with OSHA regulations.

2.8 RAILING

A. Design, furnish and install FRP railing systems where indicated on the Drawings.

B. Design
1. Design to meet or exceed OSHA requirements with a minimum factor of safety of 2.0.
2. Design members for rails, posts, kick plates, base plates, fasteners, and necessary appurtenances for a complete and rigid installation in accordance with structural engineering principles and manufacturer requirements.
3. Provide kick plates where required by OSHA.

C. Manufacture
1. Guard rails to have 3 horizontal rails with top rail at 42 inches above walking surface.
2. Handrails at stairs to have 3 horizontal rails with top rail at 42 inches above leading edge of stair. Provide additional grasp rail at 34 inches above leading edge of stair.
3. Posts to be minimum 2-inch square tubing with internal fitting for all connections and maximum spacing of 4 feet.
4. Make all rail and kick plate corner joints mitered at a 45 degree angle and securely fasten to posts.
5. Seal all cut edges and holes with a compatible resin.

D. Railing members to be pultruded FRP shapes manufactured with the following minimum mechanical properties:

Property	ASTM Method	Minimum Value	Units
Tensile Strength	D638	30,000	psi
Tensile Modulus	D638	2.5×10^6	psi
Compressive Strength	D695	30,000	psi
Compressive Modulus	D695	2.5×10^6	psi
Flexural Strength	D790	30,000	psi
Flexural Modulus	D790	2.0×10^6	psi
Shear Strength	D2344	4,500	psi
Density	D792	0.070	pci
24-hour Water Absorption	D570	Less than 0.60	percent
Coefficient of Thermal Expansion	D696	6.0×10^{-6}	In/in/deg F
Barcol Hardness	D696	50	

2.9 WEIR TROUGHS (NOT USED)

2.10 WEIR PLATES (NOT USED)

2.11 BAFFLE WALLS AND CHIMNEYS (NOT USED)

2.12 STOP LOGS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Field verify all dimensions before fabrication of products and indicate such measurements on shop drawing layouts. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

3.2 INSTALLATION

A. General
   1. Install FRP structures in accordance with manufacturer's assembly shop drawings. Field cut and drill FRP products with carbide or diamond tipped bits and blades only. Seal cut or drilled surfaces in accordance with manufacturer's instructions.
   2. Bond FRP items with epoxy adhesive recommended by the manufacturer of the particular items. Use solvent and abrasives to sufficiently remove the surface gloss and to remove any mold release agent or other contaminants which may interfere with proper bonding. Follow adhesive manufacturer's instructions and do not stress bonded items for a minimum of 48 hours after bonding.

B. Structural Shapes
   1. Mark materials for field assembly per shop drawing layouts. When finishing is required, complete field assemblies in final position before starting finishing operations.
   2. Connections: Make shop and field connections by bonded or bolted as indicated.
   3. Holes for Other Work: Provide holes as necessary or as indicated for securing other Work to FRP framing, and for the passage of other Work through FRP members.
   4. Seal all field cuts and drilled edges sealed with a resin compatible with the original resin and recommended by the manufacturer to prevent premature fraying at the field cut edges.
   5. Furnish anchor bolts and other connectors required for securing structural FRP to in-place Work and templates and other devices for presetting bolts and other anchors to accurate locations
   6. Setting Bases and Bearing Plates: Prior to the placement of nonshrink grout beneath base and bearing plates, clean the bottom surface of the plates of all bond-reducing materials. Clean and roughen concrete and masonry bearing surface to remove bond-reducing materials improve bonding.
      a. Set loose and attached base plates and bearing plates for structural members on wedges, leveling nuts, or other adjustable devices.
      b. Tighten anchor bolts after the supported members have been positioned and plumbed and the nonshrink grout has attained its required strength.

c. Grout base plates with nonshrink grout to assure full uniform bearing. Complete grouting prior to placing loads on the structure.

7. Field Assembly: Set structural frames accurately to the lines and elevations indicated. Align and adjust members to form a part of a complete frame or structure before permanent fastening. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly. Plumb and level individual members of the structure within required tolerances.
8. Misfits at Bolted Connections: Where misfits in bolting are encountered, the immediately notify the Engineer. Submit a method to remedy the misfit for review by the Engineer. Engineer will determine whether the remedy is acceptable or if the member must be refabricated. Methods of remedy may include, but are not limited to the following:
   a. Reaming holes that must be enlarged to admit oversized bolts.
   b. Drilling additional holes in the connection, to conform to manufacturer's standards for bolt spacing, end, and edge distances, and adding additional bolts.
   c. Rejecting the improperly fabricated member and fabricating a new member to ensure proper fit.
   d. Mid-sized or misaligned holes in members shall not be enlarged by burning of by the use of drift pins.

C. Grating
1. Layout: Each grating section shall be readily removable, except where indicated. As much as possible, provide openings and holes where indicated on the Contract Drawings. Make grating openings which fit around protrusions (pipes, cables, machinery, etc.) discontinuous at approximately the centerline of opening so each section of grating is readily removable.
2. Install the grating with a minimum 1.5-inch bearing surface at the support ends.
3. Tolerances Between Sections: Not more than ¼-inch clearance between adjacent sections or between grating and frames. Assemble adjacent sections to line up forming an uninterrupted straight line, where possible.
4. Provide grating free from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles, and pits. Except for non-slip surfaces provide a smooth finish.
5. Miter and bond seat angles corners to produce smooth, even, level seating surface.
6. Install grating so that the top surface is level and even with adjacent walking surfaces. There shall be no protrusions above the top surface.
7. Fasten all grating to supports as specified herein.

D. Ladders
1. Install FRP ladders per manufacturer's instructions in locations shown on the Drawings. Install safety devices when shown on the drawings or specified herein.

E. Weirs and Baffles: Install weirs and baffles in accordance with the manufacturer's recommendations as shown on the drawings. Joints between weir plates and concrete and abutting weir plates shall be water tight. Seal all weirs with sealant approved by Engineer after weirs are set, checked for level, and are within specified tolerances.

3.3 SITE QUALITY CONTROL

A. Site Tests And Inspections

1. Stop Logs: After stop logs are installed, conduct field leakage tests at specified operating conditions. Provide test results to Engineer showing that the field leakage test is with allowable leakage limits specified herein.

END OF SECTION

SECTION 06 64 00
PLASTIC PANELING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes glass-fiber reinforced plastic (FRP) wall paneling and trim accessories.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For plastic paneling and trim accessories.

1.3 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 450 or less.

PART 2 – PRODUCTS

2.1 PLASTIC SHEET PANELING

A. General: Gelcoat-finished, glass-fiber reinforced plastic panels complying with ASTM D 5319.
   1. Manufacturers:Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Kemlite Company Inc.
      b. Marlite.
      c. Nudo Products, Inc.
   2. Nominal Thickness: Not less than 0.075 inch (1.9 mm).
   3. Surface Finish: Smooth.
   4. Color: White As indicated by manufacturer's designations As selected by Architect from manufacturer's full range.

2.2 ACCESSORIES

A. Trim Accessories: Manufacturer's standard one-piece vinyl extrusions designed to retain and cover edges of panels. Provide division bars, inside corners, outside corners, and caps as needed to conceal edges.
   1. Color: White.

B. Adhesive: As recommended by plastic paneling manufacturer.
   1. VOC Content: 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Sealant: Single-component, mildew-resistant, neutral-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Division 07 Section "Joint Sealants."
   1. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that could impair bond of adhesive, including oil, grease, dirt, and dust.

B. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.

C. Lay out paneling before installing. Locate panel joints where indicated, so that trimmed panels at corners are not less than 12 inches (300 mm) wide.

3.2 INSTALLATION

A. Install plastic paneling according to manufacturer's written instructions.

B. Install panels in a full spread of adhesive.

C. Install trim accessories with adhesive or staples. Do not fasten through panels.

D. Fill grooves in trim accessories with sealant before installing panels and bed inside corner trim in a bead of sealant.

E. Maintain uniform space between panels and wall fixtures. Fill space with sealant.

F. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

END OF SECTION

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DIVISION 07
THERMAL AND MOISTURE PROTECTION

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SECTION 07 13 26
SELF ADHERING MEMBRANE WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Self Adhering Membrane Waterproofing.

B. Related Sections include the following:
   1. Section 07 92 00 Joint Sealants for joint-sealant materials and installation.

1.3 SUBMITTALS

A. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.

B. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

C. Samples: For the following products:
   1. 12-by-12-inch (300-by-300-mm) square of waterproofing and flashing sheet.
   2. 12-by-12-inch (300-by-300-mm) square of insulation.

D. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for waterproofing.

F. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A firm that is approved or licensed by waterproofing manufacturer for installation of waterproofing required for this Project.

B. Source Limitations: Obtain waterproofing materials through one source from a single manufacturer.

C. Mockups: Before beginning installation, install waterproofing to 100 sq. ft. (9.3 sq. m) of wall to demonstrate surface preparation, crack and joint treatment, corner treatment, and execution quality.
   1. If Architect determines mockups do not comply with requirements, reapply waterproofing and reinstall overlying construction until mockups are approved.
   2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

D. Pre-installation Conference: Conduct conference at Project site.
   1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver liquid materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by waterproofing manufacturer.

C. Remove and replace liquid materials that cannot be applied within their stated shelf life.

D. Store rolls according to manufacturer's written instructions.

E. Protect stored materials from direct sunlight.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.
   1. Do not apply waterproofing in snow, rain, fog, or mist.

B. Maintain adequate ventilation during preparation and application of waterproofing materials.

C. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to replace waterproofing material that does not comply with requirements or that fails to remain watertight within specified warranty period.
   1. Warranty Period: Five year material from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MODIFIED BITUMINOUS SHEET WATERPROOFING

A. Modified Bituminous Sheet: Not less than 60-mil- (1.5-mm-) thick, self-adhering sheet consisting of 56 mils (1.4 mm) of rubberized asphalt laminated to a 4-mil- (0.10-mm-) thick, polyethylene film with release liner on adhesive side and formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Grace Construction Products ; Bituthene 3000
      b. Polyguard Products ; 650 membrane waterproofing
      c. Soprema: Colphene 3000
   2. Physical Properties:
      a. Tensile Strength: 250 psi (1.7 MPa) minimum; ASTM D 412, Die C, modified.
      b. Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
      c. Low-Temperature Flexibility: Pass at minus 20 deg F (minus 29 deg C); ASTM D 1970.
      d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch (3-mm) movement; ASTM C 836.
      e. Puncture Resistance: 40 lbf (180 N) minimum; ASTM E 154.
      f. Hydrostatic-Head Resistance: 150 feet (45 m) minimum; ASTM D 5385.
      g. Water Absorption: 0.15 percent weight-gain maximum after 48-hour immersion at 70 deg F (21 deg C); ASTM D 570.
      h. Vapor Permeance: 0.05 perms (2.9 ng/Pa x s x sq. m); ASTM E 96, Water Method.

2.2 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
   1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.

B. Primer: Liquid waterborne or solvent-borne primer recommended for substrate by manufacturer of sheet waterproofing material.

C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by manufacturer of sheet waterproofing material.

D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, trowel grade or low viscosity

E. Substrate Patching Membrane: Low-viscosity, two-component, asphalt-modified coating.

F. Sheet Strips: Self-adhering, rubberized-asphalt sheet strips of same material and thickness as sheet waterproofing.

G. Mastic, Adhesives, and Tape: Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer.
   1. Detail Tape: Two-sided, pressure-sensitive, self-adhering reinforced tape, 4-1/2 inches (114 mm) wide, with a tack-free protective adhesive coating on one side and release film on self-adhering side.

H. Metal Termination Bars: Aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick, predrilled at 9-inch (229-mm) centers.

2.3 DRAINAGE PANELS

A. Provide and install protection and drainage course as recommended by manufacturer's written instructions.
   1. Products:
      a. Polyguard 15
      b. Grace Hydroduct 660

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.
   1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
   2. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
   3. Verify that concrete is dry, smooth, and sound; and ready to receive waterproofing membrane.
   4. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.

E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.
   1. Install sheet strips and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch (1.6 mm).

F. Bridge and cover isolation joints or expansion joints and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips.
   1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.

G. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.
   1. Install membrane strips centered over vertical inside corners. Install 3/4-inch (19-mm) fillets of liquid membrane on horizontal inside corners and as follows:
      a. At footing-to-wall intersections, extend liquid membrane each direction from corner or install membrane strip centered over corner.
      b. At plaza deck-to-wall intersections, extend liquid membrane or sheet strips onto deck waterproofing and to finished height of sheet flashing.

H. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to ASTM D 6135.

3.3 MODIFIED BITUMINOUS SHEET WATERPROOFING APPLICATION

A. Install modified bituminous sheets according to waterproofing manufacturer's written instructions and according to recommendations in ASTM D 6135.

B. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Re prime areas exposed for more than 24 hours.

C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- (64-mm-) minimum lap widths and end laps. Overlap and seal seams and stagger end laps to ensure watertight installation.
   1. When ambient and substrate temperatures range between 25 and 40 deg F (minus 4 and plus 5 deg C), install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F (16 deg C).

D. Apply continuous sheets over sheet strips bridging substrate cracks, construction, and contraction joints.

E. Seal exposed edges of sheets at terminations not concealed by metal counter flashings or ending in reglets with mastic.

F. Install sheet waterproofing and auxiliary materials to tie into adjacent waterproofing.

G. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fish mouths and blisters. Patch with sheet waterproofing extending 6 inches (150 mm) beyond repaired areas in all directions.

H. Install protection course with butted joints over waterproofing membrane immediately.

I. Correct deficiencies in or remove sheet waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

3.4 DRAINAGE/PROTECTION BOARD INSTALLATION

A. Install drainage/protection board per manufacturer's written instructions.

3.5 PROTECTION AND CLEANING

A. Do not permit foot or vehicular traffic on unprotected membrane.

B. Protect waterproofing from damage and wear during remainder of construction period.

C. Protect installed board insulation from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 07 14 00
FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Provide and apply single-component, fluid-applied liquid waterproofing system to below grade concrete walls for cast-in-place concrete vaults and drying beds, including surface preparation. Below grade concrete walls and mat slab for the clearwell structure shall be waterproofed per Section 07 13 26.

1.2 RELATED SECTIONS

A. Section 03 30 00 Cast-in-Place Concrete

B. Section 07 13 26 Self Adhering Membrane Waterproofing

C. Section 07 92 00 Joint Sealants (for joint-sealant materials and installation)

1.3 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM C836	Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course
ASTM D41	Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
ASTM D1644	Standard Test Methods for Nonvolatile Content of Varnishes
ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Product Data: For each type of product indicated. Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.

C. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins to adjoining waterproofing, and other termination conditions which may be required.

D. Qualification Data: For qualified Installer.

E. Product Test Reports: For waterproofing, based on evaluation of comprehensive tests performed by a qualified testing agency.

F. Field quality-control reports.

G. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that is approved or licensed by manufacturer for installation of waterproofing required for this Project and is eligible to receive special warranties specified.

B. Source Limitations: Obtain waterproofing materials from single source from single manufacturer.

C. Preinstallation Conference: Conduct conference at Project site.
   1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, installation procedures, testing and inspection procedures, and protection and repairs.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer.

C. Remove and replace liquid materials that cannot be applied within their stated shelf life.

D. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, or when temperature is below 0 Degrees F.
   1. Do not apply membrane when air, material, or surface temperatures are expected to fall below 30 Degrees F within four hours of completed application.
   2. Do not apply membrane if rainfall is forecast or imminent within 12 hours.
   3. Do not apply waterproofing membrane to any surfaces containing frost.
   4. Consult manufacturer for applications to green concrete.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.8 WARRANTY

A. Special Warranty: The special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents, and shall be in addition to, and run concurrent with, other warranties made under requirements of the Contract Documents.

B. Provide written warranty signed by waterproofing manufacturer and installer agreeing to repair or replace waterproofing that does not meet requirements or that does not remain watertight within the specified warranty period.

C. Warranty Period: 3 years after date of Substantial Completion.

D. Warranty does not include failure of waterproofing due to failure of substrate or formation of new joints and cracks in substrate that exceed 1/16 inch in width.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers and products are acceptable:
   1. Fluid Applied Waterproofing:
      a. Epro Services, Inc., Ecobase Waterproofing Membrane.
      b. Tremco Barrier Solutions, Tuff-N-Dri H8 Waterproofing.
      c. Engineer approved equal.

2.2 PERFORMANCE CRITERIA

A. Waterproofing Membrane:
   1. Single-component, polymer-enhanced liquid-applied membrane with the following minimum properties:
      a. Solids content, ASTM D1644, 60% minimum.
      b. Tensile Strength, ASTM D412: 15 psi, minimum.
      c. Elongation, ASTM D412: 1100%, minimum.
      d. Water Vapor Transmission, ASTM E96: 1 perms maximum (40 mil dry coat).
      e. Hydrostatic Pressure Resistance, 8 feet water head, minimum.
      f. Adhesion, ASTM C836, minimum 11 lb/inch to peel from concrete and masonry.

B. Sealants and Accessories: Manufacturer's recommended sealants and accessories.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
   2. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D4263.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Close off penetrations to prevent spillage and migration of waterproofing fluids.

D. Remove grease, oil, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

E. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.

3.3 JOINTS, CRACKS, AND TERMINATIONS

A. Prepare and treat substrates to receive waterproofing membrane, including expansion joints, construction joints, cracks, deck drains, corners, and penetrations according to manufacturer's written instructions.

3.4 MEMBRANE APPLICATION

A. Apply using appropriate equipment and nozzles, per manufacturer’s recommendations. Start application with manufacturer's authorized representative present.

B. Membrane: Spray apply asphalt emulsion membrane to substrates and adjoining surfaces indicated. Spread to a minimum wet thickness per manufacturer’s specification to achieve listed hydrostatic resistance, minimum of 60 mils.

C. Apply waterproofing over prepared joints and up wall terminations and vertical surfaces to heights indicated or required by manufacturer.

D. Allow product to cure prior to backfilling.

E. When buried surfaces that have been waterproofed are not backfilled within 30 days of membrane applications, membrane shall be coated with whitewash. Any formula for mixing the whitewash may be used which is not detrimental to the membrane and produces a uniformly coated white surface which remains until backfill is placed.

3.5 FIELD QUALITY CONTROL

A. Engage a full-time site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions; surface preparation; and application of the membrane, flashings, protection, and drainage components; furnish daily reports to Engineer.

3.6 CLEANING AND PROTECTION

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

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SECTION 07 19 00
WATER REPELLENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes penetrating water-repellent treatments for the following vertical and horizontal surfaces:
   1. Concrete unit masonry.

B. Related Requirements:
   1. Section 04 22 00 – Concrete Unit Masonry for integral water-repellent admixture for unit masonry assemblies.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include manufacturer's printed statement of VOC content.
   2. Include manufacturer's standard colors.
   3. Include manufacturer's recommended number of coats for each type of substrate and spreading rate for each separate coat.
   4. Include printout of current "MPI Approved Products List" for each product category specified in Part 2 that specifies water repellents approved by MPI, with the proposed product highlighted.

B. Samples: For each type of water repellent and substrate indicated, 12 by 12 inches (300 by 300 mm) in size, with specified water-repellent treatment applied to half of each Sample.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Applicator.

B. Product Certificates: For each type of water repellent.

C. Preconstruction Test Reports: For water-repellent-treated substrates.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.6 QUALITY ASSURANCE

A. Applicator Qualifications: An employer of workers trained and approved by manufacturer.

B. MPI Standards: Comply with MPI standards indicated and provide water repellents listed in its "MPI Approved Products List."

C. Mockups: Prepare mockups of each required water repellent on each type of substrate required to demonstrate aesthetic effects, for preconstruction testing, and to set quality standards for materials and execution.
   1. Locate mockups on masonry sample panels.
      a. Size: 10 sq. ft. (9.3 sq. m) each.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing: Engage a qualified testing agency to perform preconstruction testing of water repellents on field mockups.
   1. In addition to verifying performance requirements, use mockups to verify manufacturer's written instructions for application procedure and optimum rates of product application to substrates.
   2. Propose changes to materials and methods to suit Project.
   3. Notify Architect seven days in advance of the dates and times when mockups will be tested.

1.8 FIELD CONDITIONS

A. Limitations: Proceed with application only when the following existing and forecasted weather and substrate conditions permit water repellents to be applied according to manufacturers' written instructions and warranty requirements:
   1. Concrete surfaces and mortar have cured for not less than 28 days.
   2. Building has been closed in for not less than 30 days before treating wall assemblies.
   3. Ambient temperature is above 40 deg F (4.4 deg C) and below 100 deg F (37.8 deg C) and will remain so for 24 hours.
   4. Substrate is not frozen and substrate-surface temperature is above 40 deg F (4.4 deg C) and below 100 deg F (37.8 deg C).
   5. Rain or snow is not predicted within 24 hours.
   6. Not less than 24 hours or as recommended by manufacturer whichever is more have passed since surfaces were last wet.
   7. Windy conditions do not exist that might cause water repellent to be blown onto vegetation or surfaces not intended to be treated.
   8. Wall must be dry and free of moisture prior to application.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Applicator agree(s) to repair or replace materials that fail to maintain water repellency specified in "Performance Requirements" Article within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Performance: Water repellents shall meet the following performance requirements as determined by preconstruction testing on substrates representing those indicated for this Project.

B. Water Absorption: Minimum 80 percent reduction of water absorption after 24 hours for treated compared to untreated specimens when tested according to the following:
   1. Concrete Masonry Units: ASTM C 140.

C. Water-Vapor Transmission: Comply with one or both of the following:
   1. Maximum 10 percent reduction water-vapor transmission of treated compared to untreated specimens, according to ASTM E 96/E 96M.
   2. Minimum 80 percent water-vapor transmission of treated compared to untreated specimens, according to ASTM D 1653.

D. Water Penetration and Leakage through Masonry: Minimum 90 percent reduction in leakage rate of treated compared to untreated specimens, according to ASTM E 514/E 514M.

E. Durability: Maximum 5 percent loss of water-repellent performance after 2500 hours of weathering according to ASTM G 154 compared to water-repellent-treated specimens before weathering.

2.2 PENETRATING WATER REPELLENTS

A. Silane, Penetrating Water Repellent: Clear, containing 20 percent or more solids of alkyltrialkoxysilanes; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with 400 g/L or less of VOCs.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide BASF Corp. - Construction Chemicals; Enviroseal 20 or a comparable product by one of the following:
      a. Advanced Chemical Technologies, Inc.
      b. Kelly-Moore Paint Company Inc.
      c. PROSOCO, Inc.
      d. Tnemec Inc.
      e. W. R. Meadows, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements and conditions affecting performance of the Work.
   1. Verify that surfaces are clean and dry according to water-repellent manufacturer's requirements. Check moisture content in three representative locations by method recommended by manufacturer.
   2. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.
   3. Verify that required repairs are complete, cured, and dry before applying water repellent.

B. Test pH level according to water-repellent manufacturer's written instructions to ensure chemical bond to silica-containing or siliceous minerals.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. New Construction and Repairs: Allow concrete and other cementitious materials to age before application of water repellent, according to repellent manufacturer's written instructions.

B. Cleaning: Before application of water repellent, clean substrate of substances that could impair penetration or performance of product according to water-repellent manufacturer's written instructions.

C. Protect adjoining work, including mortar and sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live vegetation.

D. Coordination with Mortar Joints: Do not apply water repellent until pointing mortar for joints adjacent to surfaces receiving water-repellent treatment has been installed and cured.

E. Coordination with Sealant Joints: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.
   1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required.

3.3 APPLICATION

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.

B. Apply coating of water repellent on surfaces to be treated using 15 psi- (103 kPa-) pressure spray with a fan-type spray nozzle roller or brush to the point of saturation. Apply coating in dual passes of uniform, overlapping strokes. Remove excess material; do not allow material to puddle beyond saturation. Comply with manufacturer's written instructions for application procedure unless otherwise indicated.

C. Apply a second saturation coating, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

3.4 FIELD QUALITY CONTROL

A. Testing of Water-Repellent Material: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when water repellent is being applied:
   1. Owner will engage the services of a qualified testing agency to sample water-repellent material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
   2. Testing agency will perform tests for compliance of water-repellent material with product requirements.

B. Coverage Test: In the presence of Architect, hose down a dry, repellent-treated surface to verify complete and uniform product application. A change in surface color will indicate incomplete application.
   1. Notify Architect seven days in advance of the dates and times when surfaces will be tested.
   2. Reapply water repellent until coverage test indicates complete coverage.

3.5 CLEANING

A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Correct damage to work of other trades caused by water-repellent application, as approved by Architect.

B. Comply with manufacturer's written cleaning instructions.

END OF SECTION

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SECTION 07 21 00
THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Perimeter insulation under slabs-on-grade.
   2. Perimeter wall insulation (supporting backfill).
   3. Concealed building insulation.
   4. Exposed interior building insulation.

1.3 DEFINITIONS

A. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers; produced in boards and blanket with latter formed into batts (flat-cut lengths) or rolls.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency for insulation products.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of building insulation through one source from a single manufacturer.

B. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency. Insulating materials, where exposed as installed in buildings of any type of construction, shall have a flame spread index of not more than 25 and a smoke-developed index of not more than 450.
   1. Surface-Burning Characteristics: ASTM E 84.
   2. Fire-Resistance Ratings: ASTM E 119.
   3. Combustion Characteristics: ASTM E 136.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect plastic insulation as follows:
   1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
   2. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
   3. Complete installation and concealment, where designed for concealment, of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FOAM-PLASTIC BOARD INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and density indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively:
   1. Manufacturers:
      a. DiversiFoam Products.
      b. Dow Chemical Company.
      c. Owens Corning.
      d. Pactiv Building Products Division.
   2. Type IV, 1.60 lb/cu. ft. (26 kg/cu. m), unless otherwise indicated.

2.3 POLYISOCYANURATE FOAM-PLASTIC BOARD INSULATION

A. Polyisocyanurate Board Insulation, Foil Faced: ASTM C1289, foil faced, Type I, Class 1 or 2.
   1. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
   2. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.

B. Exposed Rigid Foam Board Insulation: closed cell polyisocyanurate foam board with glass fiber reinforced core, ASTM C1289, Type I, Class 2, meeting the following criteria:
   1. Thermal Resistance (ASTM C1363 @ 75 deg. F): R-6.5 per 1 inch of thickness (RSI 1.14 per 25 mm of thickness).
   2. Density (ASTM D1622): nominal 2.0 pcf.
   3. Compressive Strength (ASTM D1621): minimum 25 psi.
   4. Board Sizes: 48 inches (1,220 mm) wide, 144 inches (3,660 mm) long.

5. Board Thickness: 3 inches (75 mm)
6. Board Edges: Shiplapped.
7. Faces: 4.0 mil (0.1 mm) thick white embossed aluminum facer one side, and a 1.25 mil (0.032 mm) thick plain embossed aluminum facer on the other side.
8. Foam Surface Burning Characteristics (ASTM E84): flame spread < 25, smoke developed < 450.
9. Water Vapor Transmission (ASTM E96): less than 0.03 perms.
10. Water Absorption by Volume (ASTM C209): maximum 0.1 percent.
11. Manufacturer's standard White Foil Tape, Interlocking PVC Closures, and J-Channels for joint trim and closure.
12. Basis of Design Product and Manufacturer: THERMAX™ Heavy Duty Insulation Board as manufactured by The Dow Chemical Company.

2.4 GLASS-FIBER BLANKET INSULATION

A. Manufacturers:
1. CertainTeed Corporation.
2. Guardian Fiberglass, Inc.
3. Johns Manville.
4. Knauf Fiber Glass.
5. Owens Corning.

B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

C. Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type II, Class A (membrane-faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with reinforced polyethylene vapor retarder meeting requirements of ASTM C 1136, with permeance not greater than 0.02 perm (1.15 ng/Pa x s x sq. m) when tested according to ASTM E 96, Desiccant Method.

D. Where glass-fiber blanket insulation is indicated by the following thicknesses, provide blankets in batt or roll form with thermal resistances indicated:
1. 3-1/2 inches (89 mm) thick with a thermal resistance of 13 deg F x h x sq. ft./Btu at 75 deg F (2.3 K x sq. m/W at 24 deg C).
2. 5-1/2 inches (140 mm) thick with a thermal resistance of 19 deg F x h x sq. ft./Btu at 75 deg F (3.3 K x sq. m/W at 24 deg C).
3. 6-1/2 inches (165 mm) thick with a thermal resistance of 21 deg F x h x sq. ft./Btu at 75 deg F (3.7 K x sq. m/W at 24 deg C).
4. 10 inches (254 mm) thick with a thermal resistance of 30 deg F x h x sq. ft./Btu at 75 deg F (5.2 K x sq. m/W at 24 deg C).

E. Single-Component Nonsag Urethane Sealant: ASTM C 920, Type I, Grade NS, Class 25, Use NT related to exposure, and Use O related to vapor-barrier-related substrates.

F. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and with demonstrated capability to bond vapor retarders securely to substrates indicated.

2.5 AUXILIARY INSULATING MATERIALS

A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and for other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of substances harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

3.3 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.

C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.

E. For preformed insulating units, provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.4 INSTALLATION OF PERIMETER AND UNDER-SLAB INSULATION

A. On vertical surfaces, set insulation units in adhesive applied according to manufacturer's written instructions. Use adhesive recommended by insulation manufacturer.
   1. If not otherwise indicated, extend insulation a minimum of 36 inches below exterior grade line.

B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

C. Protect below-grade insulation on vertical surfaces from damage during backfilling by applying protection course with joints butted. Set in adhesive according to insulation manufacturer's written instructions.

D. Protect top surface of horizontal insulation from damage during concrete work by applying protection course with joints butted.

3.5 INSTALLATION OF FOUNDATION WALL INSULATION

A. Butt panels together for tight fit.

B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
   1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions.
   2. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application.
   3. Apply insulation standoffs to each spindle to create cavity width indicated on Drawings between concrete substrate and insulation.
   4. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation.
   5. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

3.6 Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

3.7 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Seal joints between foam-plastic insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place or set in place as z-furring is installed. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

C. Set vapor-retarder-faced units with vapor retarder to warm-in-winter side of construction, unless otherwise indicated.
   1. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

D. Install mineral-fiber insulation in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures.
4. Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
5. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

E. Stuff glass-fiber loose-fill insulation into miscellaneous voids and cavity spaces where shown. Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).

F. Install exposed, faced polyisocyanurate insulation with panels vertical, in pattern indicated, and in accordance with manufacturer's instructions. Trim and seal all joints.

3.8 INSTALLATION OF VAPOR RETARDERS

A. General: Install in accordance with Division 7 Section, "Vapor Retarders."

3.9 PROTECTION

A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

SECTION 07 26 00
VAPOR RETARDERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Reinforced-polyethylene vapor retarders.

B. Related Requirements:

   1. Section 03 30 00 - Cast-in-Place Concrete for under-slab vapor retarders.
   2. Section 07 21 00 - Thermal Insulation for vapor retarders integral with insulation products.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

PART 2 - PRODUCTS

2.1 REINFORCED-POLYETHYLENE VAPOR RETARDERS

A. Reinforced-Polyethylene Vapor Retarders: Sheet with outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nylon cord or polyester scrim and weighing not less than **20 lb/1000 sq. ft. (9 kg/100 sq. m)**, with maximum permeance rating of 0.1 perm (5.7 ng/Pa x s x sq. m).

2.2 ACCESSORIES

A. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

B. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.

C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to vapor retarders, including removing projections capable of puncturing vapor retarders.

3.2 INSTALLATION OF VAPOR RETARDERS ON FRAMING

A. Place vapor retarders on side of construction indicated on Drawings.

B. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives, vapor retarder fasteners, or other anchorage system as recommended by manufacturer. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.

C. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs and sealing with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Locate all joints over framing members or other solid substrates.

D. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.

E. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

3.3 PROTECTION

A. Protect vapor retarders from damage until concealed by permanent construction.

END OF SECTION

SECTION 07 41 13.16
STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes
1. Standing-seam metal roof panels.
2. Roof Insulation

B. Related Sections:
1. Division 7 Section “Metal Soffit and Wall Panels” for metal panels used in horizontal soffit applications.
2. Division 7 Section “Snow Guards” for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.

1.3 PRE-INSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.
1. Meet with Owner, Owner’s Representative, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof accessories and roof-mounted equipment.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review structural loading limitations of deck, purlins, roof joists, and girders during and after roofing.
6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
8. Review temporary protection requirements for metal panel systems during and after installation.
9. Review procedures for repair of metal panels damaged after installation.
10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:
   1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
   2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).

C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.
   1. Include similar Samples of trim and accessories involving color selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
   1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

E. Copper Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

F. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.10 COORDINATION

A. Coordinate sizes and locations of roof penetrations with actual installation.

B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leak-proof, secure, and noncorrosive installation.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems, which fail in materials or workmanship within specified warranty period.
   1. Special warranty includes roof membrane, base flashings, roof insulation, fasteners, and other components of roofing system.
   2. Failures include, but are not limited to, the following:
      a. Structural failures including rupturing, cracking, or puncturing.
      b. Deterioration of metals and other materials beyond normal weathering.
   3. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.

c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 25 years from date of Substantial Completion.

C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 25 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Solar Reflectance Index: Not less than 29 when calculated according to ASTM E 1980.

B. Energy Performance: Provide roof panels that are listed on the EPA/DOE's ENERGY STAR "Roof Product List" for steep-slope roof products.

C. Energy Performance: Provide roof panels according to one of the following when tested according to CRRC-1:

1. Three-year, aged solar reflectance of not less than 0.55 and emissivity of not less than 0.75.
2. Three-year, aged Solar Reflectance Index of not less than 64 when calculated according to ASTM E 1980.

D. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.
3. Deflection Limits: For wind loads, no greater than 1/180 of the span.

E. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E 1680 or ASTM E 283 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).

F. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 or ASTM E 331 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).

G. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.

H. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL 90.

I. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 STANDING-SEAM METAL ROOF PANELS

A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.
2. Low Slope Water-Tightness: Provide and install only metal roof panel system, including panels, clips, gaskets, sealants, and other accessories rated to provide required weather- and water-tightness at the stipulated slope of 2 inches rise in 12 inches of run.

B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.
1. Basis of Design:
   a. Firestone
   b. Product: Una-Clad UC-6
2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
   a. Nominal Thickness: 22 Gauge (0.034 inch).
3. Clips: Two-piece floating to accommodate thermal movement.
   a. Material: 0.064-inch- (1.63-mm-) nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
4. Joint Type: Double folded.
5. Panel Coverage: 16 inches (406 mm).
6. Panel Height: 1.5 inches (38 mm).

2.3 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured **or approved** by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated **and that produce FM Global-approved roof insulation**.

B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.

C. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.4 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation **and cover boards** to substrate, and acceptable to roofing system manufacturer.

C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
1. Modified asphaltic, asbestos-free, cold-applied adhesive.
2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
3. Full-spread spray-applied, low-rise, two-component urethane adhesive.

D. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, **1/2 inch (13 mm)**.

E. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

2.5 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Underlayment: Provide 100% self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils (0.76 mm) thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
1. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.
2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.

2.6 MISCELLANEOUS MATERIALS

A. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

B. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include,

but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

C. Gutters: Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2400-mm-) long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches (914 mm) o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels.

D. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot- (3-m-) long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts to match gutters.

E. Panel Fasteners: Self-tapping screws designed to withstand design loads.

F. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.7 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.8 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:
1. Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
1. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.
    a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Examine roof deck surface to ensure proper fastening and appropriate substrate for insulation, waterproof underlayment and metal roof panel installation.

3.3 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.
   1. Apply over the entire roof surface on top of roof insulation.

B. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 07 62 00 "Sheet Metal Flashing and Trim."

3.4 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels in the direction shown on the drawings. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
   1. Shim or otherwise plumb substrates receiving metal panels.
   2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
   3. Install screw fasteners in predrilled holes.
   4. Locate and space fastenings in uniform vertical and horizontal alignment.
   5. Install flashing and trim as metal panel work proceeds.
   6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
   7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
   8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:
   1. Steel Panels: Use galvanized-steel fasteners.

C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
   1. Install clips to supports with self-tapping fasteners.
   2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
   3. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
   4. Watertight Installation:
      a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
      b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
      c. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
   1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
   1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
   2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

H. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches (914 mm) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion. Provide SMACNA expansion joints every 40 feet minimum.

I. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1524 mm) o.c. in between.
   1. Provide elbows at base of downspouts to direct water away from building.
   2. Connect downspouts to underground drainage system indicated.

J. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.5 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.7 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

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SECTION 07 42 13.53
METAL SOFFIT AND WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes metal soffit and wall panels.

B. Related Sections:
1. Section 07 41 13.16 - Metal Roof Panels for lap-seam metal roof panels.
2. Section 07 62 00 - Sheet Metal Flashing and Trim.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:
1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).

C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, tests performed by a qualified testing agency.

C. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockup of typical wall, roof eave, including fascia, and soffit approximately three panels wide by 3 feet high plus full eave dimension, including attachments and accessories.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of walls, and other adjoining work to provide a leak-proof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems which fail in materials or workmanship within the specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including rupturing, cracking, or puncturing.
      b. Deterioration of metals and other materials beyond normal weathering.
   2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

   1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 25 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
   1. Wind Loads: As indicated on Drawings.
   2. Other Design Loads: As indicated on Drawings.
   3. Deflection Limits: For wind loads, no greater than 1/240 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E 283 at the following test-pressure difference:
   1. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa).

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
   1. Test-Pressure Difference: 2.86 lbf/sq. ft. (137 Pa).

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METAL SOFFIT AND WALL PANELS

A. General: Provide metal soffit and wall panels designed to be installed by lapping side edges of adjacent panels and mechanically attaching through panel to supports using exposed fasteners in a regular pattern. Include accessories required for weathertight installation.

B. Metal Soffit and Wall Panels: Match material of metal roof panels.
   1. Sealant: As required at transitions for weathertight construction.
   2. Basis of Design Product: PBD Panel as manufactured by MBCI Metal Roof and Wall Systems
   3. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
      a. Nominal Thickness: 22 gage minimum.
      b. Exterior Finish: Metallic fluoropolymer.
      c. Color: Match metal roof panels.
   4. Panel Coverage: 32 inches.
   5. Panel Depth: 0.625 inch .

2.3 MISCELLANEOUS MATERIALS

A. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
   1. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

B. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal panels.

C. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

D. Panel Sealants: Provide from the following options sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
   1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
   2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.

3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.4 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile for full width of panel.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
   1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
   3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
   4. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
      a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal soffit and wall panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:
   1. Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
   1. Examine framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal panel manufacturer.
   2. Examine sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal panel manufacturer.
      a. Verify that air- or water-resistive barriers been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.
   1. Soffit Framing: Wire tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

3.3 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels vertically. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
   1. Shim or otherwise plumb substrates receiving metal panels.
   2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
   3. Install screw fasteners in predrilled holes.
   4. Locate and space fastenings in uniform vertical and horizontal alignment.
   5. Install flashing and trim as metal panel work proceeds.
   6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
   7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:
   1. Steel Panels: Use galvanized-steel fasteners.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
   1. Apply panels and associated items true to line for neat and weathertight enclosure.
   2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
   3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
   4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.

E. Watertight Installation:
   1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels and elsewhere as needed to make panels watertight.
   2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
   3. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
   1. Install components required for a complete metal panel system including trim, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.

G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
   1. Install exposed flashing and trim that is without buckling, and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
   2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

3.4 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07 54 23
THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Adhered thermoplastic polyolefin (TPO) roofing system. (Contractors Option)
2. Mechanically fastened, thermoplastic polyolefin (TPO) roofing system.
3. Substrate board.
4. Roof insulation.
5. Cover board.
6. Walkways.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. For insulation and roof system component fasteners, include copy of FM Approvals' RoofNav listing.

B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:
1. Layout and thickness of insulation.
2. Base flashings and membrane termination details.
3. Flashing details at penetrations.
4. Tapered insulation layout, thickness, and slopes.
5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Tie-in with adjoining air barrier.

C. Samples: For the following products:
1. Roof membrane and flashings, of color required.
2. Walkway pads or rolls, of color required.

D. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
    a. Submit evidence of compliance with performance requirements.
2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.

C. Research reports.

D. Field Test Reports:
1. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field quality-control reports.

F. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is UL listed or listed in FM Approvals' RoofNav for roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accelerated Weathering: Roof membrane shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.

B. Impact Resistance: Roof membrane shall resist impact damage when tested according to ASTM D 3746, ASTM D 4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures (strength design) when tested according to FM Approvals 4474, UL 580, or UL 1897:
1. Zone 1 (Roof Area Field): 30 lbf/sq. ft.
2. Zone 2 (Roof Area Perimeter): 50 lbf/sq. ft.
3. Zone 3 (Roof Area Corners): 75 lbf/sq. ft.
    a. 6 feet from each edge of roof at corners.

D. ENERGY STAR Listing: Roofing system shall be listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.

E. Energy Performance: Roofing system shall have an initial solar reflectance of not less than 0.70 and an emissivity of not less than 0.75 when tested according to CRRC-1.

F. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.2 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

A. TPO Sheet: ASTM D 6878/D 6878M, internally fabric- or scrim-reinforced, TPO sheet.
1. Thickness: 60 mils (1.5 mm) minimum.
2. Exposed Face Color: White.

2.3 AUXILIARY ROOFING MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.

B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils (1.4 mm) thick, minimum, of same color as TPO sheet.

C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.

D. Bonding Adhesive: Manufacturer's standard.

E. Slip Sheet: Manufacturer's standard, of thickness required for application.

F. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.

G. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.

H. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.4 SUBSTRATE BOARDS

A. Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum board or ASTM C 1278/C 1278M, fiber-reinforced gypsum board.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. CertainTeed Corporation.
b. Georgia-Pacific Gypsum LLC.
c. National Gypsum Company.
d. USG Corporation.
2. Thickness: Type X, 5/8 inch (16 mm) thick.
3. Surface Finish: Factory primed.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.5 VAPOR RETARDER

A. Self-Adhering-Sheet Vapor Retarder: Polyethylene film laminated to layer of butyl rubber adhesive, minimum 30-mil (0.76-mm) total thickness; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

2.6 ROOF INSULATION

A. Roof insulation materials listed below are minimum values. Provide roofing insulation as required to meet performance requirements and as listed in the roofing manufacturer's requirements for the installed roof system meeting requirements for performance and warranty.

B. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.45-lb/cu. ft. (23-kg/cu. m) minimum density, 25-psi (173-kPa) minimum compressive strength, square edged.
1. Thermal Resistance: R-value of 5.0 per inch (25.4 mm).
2. Size: 48 by 96 inches (1219 by 2438 mm).
3. Thickness:
a. Base Layer: 1-1/2 inches (38 mm).
b. Upper Layer: As required by roof manufacturer.

C. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
1. Size: 48 by 96 inches (1219 by 2438 mm).
2. Thickness:
a. Base Layer: 1-1/2 inches (38 mm).
b. Upper Layer: As required by manufacturer.

D. Tapered Insulation: Provide factory-tapered insulation boards.
   1. Material: Match roof insulation.
   2. Minimum Thickness: 1/4 inch (6.35 mm).
   3. Slope:
      a. Roof Field: 3/8 inches per foot, unless otherwise indicated on Drawings.
      b. Saddles and Crickets: 1/2 inch per foot (1:24) unless otherwise indicated on Drawings.

2.7 INSULATION ACCESSORIES

A. Fasteners: Factory-coated steel fasteners with metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.

B. Rhinobond Plates:
   1. Carlisle SynTec:
      a. Plates engineered as companion assembly with Carlisle Fasteners.
      b. Used to secure insulation, hardboard, and membrane as required by Membrane Manufacturer.
   2. Sika Sarnafil:
      a. Plates engineered as companion assembly with Sarnafasteners.
      b. Used to secure insulation, hardboard, and membrane as required by Membrane Manufacturer.

C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
   1. Modified asphaltic, asbestos-free, cold-applied adhesive.
   2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
   3. Full-spread, spray-applied, low-rise, two-component urethane adhesive.

D. Select cover board from one of the following as required to meet roofing manufacturer's requirements:
   1. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum board or ASTM C 1278/C 1278M fiber-reinforced gypsum board.
      a. Thickness: 1/2 inch (13 mm).
      b. Surface Finish: Factory primed.
   2. Cover Board: ASTM C 1325, fiber-mat-reinforced cementitious board, 7/16 inch (11 mm) thick.
   3. Cover Board: ASTM C 1289 Type II, Class 4, Grade 1, 1/2-inch- (13-mm-) thick polyisocyanurate, with a minimum compressive strength of 80 psi (551 kPa).

E. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric; water permeable and resistant to UV degradation; type and weight as recommended by roofing system manufacturer for application.

2.8 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch (5 mm) thick and acceptable to roofing system manufacturer.
   1. Size: Approximately 36 by 60 inches (914 by 1524 mm).
   2. Color: Contrasting with roof membrane.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

3.2 PREPARATION

A. Perform fastener-pullout tests according to roof system manufacturer's written instructions.
   1. Submit test result within 24 hours after performing tests.
      a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

3.3 ROOFING INSTALLATION, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions, FM Approvals' RoofNav assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning Work on adjoining roofing.

C. Install roof membrane and auxiliary materials to tie into existing roofing to maintain weathertightness of transition.

3.4 SUBSTRATE BOARD INSTALLATION

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches (610 mm) in adjacent rows.
   1. At steel roof decks, install substrate board at right angle to flutes of deck.
      a. Locate end joints over crests of steel roof deck.
   2. Tightly butt substrate boards together.
   3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
   4. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.

5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.

3.5 INSTALLATION OF VAPOR RETARDER

A. Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 and 6 inches (90 and 150 mm), respectively.
1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Seal laps by rolling.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSULATION INSTALLATION

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and roof insulation manufacturer's written instructions for installing roof insulation.

C. Installation Over Metal Decking:
1. Install base layer of insulation with end joints staggered not less than 12 inches (305 mm) in adjacent rows and with long joints continuous at right angle to flutes of decking.
    a. Locate end joints over crests of decking.
    b. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
    c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    d. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
    e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).
        1) Trim insulation so that water flow is unrestricted.
    f. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
    g. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
    h. Mechanically attach base layer of insulation and substrate board using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
        1) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches (305 mm) from previous layer of insulation.
    a. Install with long joints continuous and with end joints staggered not less than 12 inches (305 mm) in adjacent rows.
    b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    c. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
    d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).
        1) Trim insulation so that water flow is unrestricted.
    e. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
    f. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
    g. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification, as follows:
        1) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
3. Mechanically attach base layer of insulation and substrate board using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to decks.
    a. Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
4. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches (305 mm) from previous layer of insulation.
    a. Install with long joints continuous and with end joints staggered not less than 12 inches (305 mm) in adjacent rows.
    b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    c. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
    d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).
        1) Trim insulation so that water flow is unrestricted.
    e. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
    f. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
    g. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification, as follows:
        1) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.7 INSTALLATION OF COVER BOARDS

A. Where cover boards are called for by the roofing manufacturer, install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction.
   1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
   2. At internal roof drains, conform to slope of drain sump.
      a. Trim cover board so that water flow is unrestricted.
   3. Cut and fit cover board tight to nailers, projections, and penetrations.
      a. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

B. Install slip sheet over cover board and beneath roof membrane.

3.8 ADHERED ROOFING INSTALLATION (Contractor's Option)

A. If selected, the installed system must meet all performance and warranty requirements as for the Basis of Design, mechanically fastened roof system.

B. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.

C. Unroll roof membrane and allow to relax before installing.

D. Start installation of roofing in presence of roofing system manufacturer's technical personnel.

E. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

F. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.

G. Fabric-Backed Roof Membrane Adhesive: Apply to substrate at rate required by manufacturer, and install fabric-backed roof membrane.

H. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.

I. Apply roof membrane with side laps shingled with slope of roof deck where possible.

J. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings, to ensure a watertight seam installation.
   1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.
   2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.

3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

K. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.9 MECHANICALLY FASTENED ROOFING INSTALLATION (Basis of Design)

A. Mechanically fasten roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.

B. Unroll roof membrane and allow to relax before installing.

C. For in-splice attachment, install roof membrane with long dimension perpendicular to steel roof deck flutes.

D. Start installation of roofing in presence of roofing system manufacturer's technical personnel.

E. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

F. Mechanically fasten or adhere roof membrane securely at terminations, penetrations, and perimeter of roofing.

G. Apply roof membrane with side laps shingled with slope of roof deck where possible.

H. In-Seam Attachment: Secure one edge of TPO sheet using fastening plates or metal battens centered within seam, and mechanically fasten TPO sheet to roof deck.

I. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.
1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and flashing sheet.
2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

J. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

K. Rhinobond Option:
1. Preparation: Using test strip of membrane and loose Rhinobond plates, provide at least four (4) varied heat settings to calibrate Rhinobond welder for operation during each work period.
2. Roll out and set membrane. Follow Manufacturer’s written instructions:
3. Provide 3 inches (75 mm) shingled lap seaming area in all membrane overlaps.
4. Weld random perimeter Rhinobond plates to secure field membrane from shifting during seam and field welds.

5. Identify remaining Rhinobond plates and weld membrane using repeated leap frog method of welding followed by placement of cooling magnets.

3.10 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.11 WALKWAY INSTALLATION

A. Flexible Walkways:
1. Install flexible walkways at the following locations:
   a. Perimeter of each rooftop unit.
   b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
   c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
   d. Top and bottom of each roof access ladder.
   e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
   f. Locations indicated on Drawings, but not less than the amount required to accommodate foot traffic from the roof hatch to all points of service on rooftop-mounted mechanical equipment.
   g. As required by roof membrane manufacturer's warranty requirements.
2. Provide 6-inch (76-mm) clearance between adjoining pads.
3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.12 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Formed low-slope roof sheet metal fabrications.
2. Formed steep-slope roof sheet metal fabrications.
3. Formed wall sheet metal fabrications.

B. Related Requirements:
1. Division 6 Section, "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Division 7 Section "Thermoplastic Polyolefin (TPO) Roofing" for materials and installation of sheet metal flashing and trim integral with roofing.
3. Division 7 Section "Metal Soffit and Wall Panels" for sheet metal flashing and trim integral with metal wall panels.
4. Division 7 Section "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.

1.3 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site in conjunction with pre-roofing conference.
1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
3. Review requirements for insurance and certificates if applicable.
4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

B. Shop Drawings: For sheet metal flashing and trim.
   1. Include plans, elevations, sections, and attachment details.
   2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.
   3. Include identification of material, thickness, weight, and finish for each item and location in Project.
   4. Include details for forming, including profiles, shapes, seams, and dimensions.
   5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
   6. Include details of termination points and assemblies.
   7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
   8. Include details of roof-penetration flashing.
   9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counter flashings as applicable.
   10. Include details of special conditions.
   11. Include details of connections to adjoining work.
   12. Detail formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches (1:10).

C. Samples for Verification: For each type of exposed finish.
   1. Sheet Metal Flashing: 12 inches (300 mm) long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1. For copings and roof edge flashings that are FM approved, shop shall be listed as able to fabricate required details as tested and approved.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.10 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 25 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet according to ASTM A 653/A 653M, G90 (Z275) coating designation, prepainted by coil-coating process to comply with ASTM A 755/A 755M.
   1. Surface: Smooth, flat.
   2. Exposed Coil-Coated Finish:
      a. Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   3. Color: Metallic Champagne, Match Architect's sample.
   4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil (0.013 mm).

2.3 UNDERLAYMENT MATERIALS

A. Felt: ASTM D 226/D 226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.

B. Synthetic Underlayment: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over 220 deg F (111 deg C); and complying with physical requirements of ASTM D 226/D 226M for Type I and Type II felts.

C. Self-Adhering, High-Temperature Sheet: Minimum 30 mils (0.76 mm) thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer according to written recommendations of underlayment manufacturer.
   1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C) or higher.
   2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C) or lower.

D. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. (0.16 kg/sq. m) minimum.

2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal.
   1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
      a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
      b. Blind Fasteners: High-strength stainless-steel rivets suitable for metal being fastened.
      c. Spikes and Ferrules: Do not use.
   2. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.

D. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.

G. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
   1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
   2. Obtain field measurements for accurate fit before shop fabrication.
   3. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
   4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines

indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

C. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

D. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

E. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.

F. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

G. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.

H. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

I. Downspouts: Fabricate rectangular downspouts to dimensions indicated, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors.
1. Fabricate from the following materials:
   a. Galvanized Steel: **0.022 inch (0.56 mm)**.

J. Parapet Scuppers: Fabricate scuppers to dimensions required, with closure flange trim to exterior, 4-inch- (100-mm-) wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fabricate from the following materials:
1. Galvanized Steel: **0.028 inch (0.71 mm)** thick.

K. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape required, complete with outlet tubes. Fabricate from the following materials:
1. Galvanized Steel: **0.028 inch (0.71 mm)** thick.

2.6 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof Edge Flashing (Gravel Stop) and Fascia Cap: Fabricate in minimum 96-inch- (2400-mm) long, but not exceeding 12-foot- (3.6-m-) long sections. Furnish with 6-inch- (150-mm-) wide, joint cover plates. Shop fabricate interior and exterior corners.

1. Joint Style: Overlapped, 4 inches (100 mm) wide.
2. Fabricate from the Following Materials:
    a. Galvanized Steel: [0.028 inch (0.71 mm)] thick.

B. Copings: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, fasten and seal watertight. Shop fabricate interior and exterior corners.
1. Coping Profile: As indicated
2. Joint Style: Standing seam.
3. Fabricate from the Following Materials:
    a. Galvanized Steel: 0.040 inch (1.02 mm) thick.

C. Base Flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
1. Galvanized Steel: 0.028 inch (0.71 mm) thick.

D. Counter flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
1. Galvanized Steel: 0.022 inch (0.56 mm) thick.

E. Flashing Receivers: Fabricate from the following materials:
1. Galvanized Steel: 0.022 inch (0.56 mm) thick.

F. Roof-Penetration Flashing: Fabricate from the following materials:
1. Galvanized Steel: 0.028 inch (0.71 mm) thick.

2.7 STEEP-SLOPE ROOF SHEET METAL FABRICATIONS

A. Drip Edges: Fabricate from the following materials:
1. Galvanized Steel: 0.022 inch (0.56 mm) thick.

B. Eave, Rake Flashing: Fabricate from the following materials:
1. Galvanized Steel: 0.022 inch (0.56 mm) thick.

C. Counter flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
1. Galvanized Steel: 0.022 inch (0.56 mm) thick.

D. Flashing Receivers: Fabricate from the following materials:
1. Galvanized Steel: 0.022 inch (0.56 mm) thick.

E. Roof-Penetration Flashing: Fabricate from the following materials:
1. Galvanized Steel: 0.028 inch (0.71 mm) thick.

2.8 WALL SHEET METAL FABRICATIONS

A. Opening Flashings in Frame Construction: Fabricate head, sill and similar flashings to extend 4 inches (100 mm) beyond wall openings. Form head and sill flashing with 2-inch-(50-mm-) high, end dams. Fabricate from the following materials:
   1. Galvanized Steel: 0.022 inch (0.56 mm) thick.

2.9 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following materials:
   1. Galvanized Steel: 0.028 inch (0.71 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
   1. Verify compliance with requirements for installation tolerances of substrates.
   2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
   3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).

B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, according to manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

C. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Prime substrate if recommended by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps and edges with roller. Cover underlayment within 14 days.

D. Apply slip sheet, wrinkle free, over underlayment or directly on substrate before installing sheet metal flashing and trim.

3.3 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, protective coatings, separators, sealants, and other miscellaneous items, as required to complete sheet metal flashing and trim system.
   1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
   2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
   3. Space cleats not more than 12 inches (300 mm) apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
   4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
   5. Torch cutting of sheet metal flashing and trim is not permitted.
   6. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
   1. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of [10 feet (3 m)] with no joints within 24 inches (600 mm) of corner or intersection.
   1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
   2. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.
   1. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
   2. Prepare joints and apply sealants to comply with requirements in Division 7 Section "Joint Sealants."
   3. copper-clad stainless steel.

3.4 ROOF FLASHING INSTALLATION

A. General: Install sheet metal flashing and trim to comply with performance requirements and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal and FM standard unless otherwise indicated and as follows. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch (75-mm) centers. Confirm that installation will resist uplift and outward forces according to recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.

C. Copings: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal and FM standard unless otherwise indicated and as follows.
1. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 16-inch (400-mm) centers.
2. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch (600-mm) centers.

D. Pipe or Post Counter flashing: Install counter flashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches (100 mm) over base flashing. Install stainless-steel draw band and tighten.

E. Counter flashing: Coordinate installation of counter flashing with installation of base flashing. Insert counter flashing in reglets or receivers and fit tightly to base flashing. Extend counter flashing 4 inches (100 mm) over base flashing. Lap counter flashing joints minimum of 4 inches (100 mm). Secure in waterproof manner by means of snap-in installation and sealant unless otherwise indicated.

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with butyl sealant and clamp flashing to pipes that penetrate roof.

3.5 WALL FLASHING INSTALLATION

A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Opening Flashings in Frame Construction: Install continuous head, sill, and similar flashings to extend 4 inches (100 mm) beyond wall openings.

3.6 MISCELLANEOUS FLASHING INSTALLATION

A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

3.7 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.8 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.

E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

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SECTION 07 72 00
ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Roof curbs.
2. Equipment supports.
3. Roof hatches.

B. Related Sections:
1. Section 05 50 00 - Metal Fabrications for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
2. Section 05 52 00 - Pipe and Tube Railings for safety railing systems not attached to roof-hatch curbs.
3. Section 07 62 00 - Sheet Metal Flashing and Trim for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.
4. Section 07 72 53 "Snow Guards" for snow guards.
5. Division 23 for standard curbs specified with rooftop units.

1.3 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing, roof insulation, and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof accessories.
1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
   1. Size and location of roof accessories specified in this Section.
   2. Method of attaching roof accessories to roof or building structure.
   3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
   4. Required clearances.

B. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.7 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 20 years from date of Substantial Completion.

1.8 COORDINATION REQUIREMENT

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Wind-Restraint Performance: As indicated on Drawings.

2.2 ROOF CURBS

A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Supported Load Capacity: As scheduled.

D. Material: Zinc-coated (galvanized) steel sheet, 0.052 inch (1.32 mm) thick.
1. Finish: Two-coat fluoropolymer.
2. Color: As selected by Architect from manufacturer's full range.

E. Construction:
1. Curb Profile: Manufacturer's standard compatible with roofing system.
2. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
3. Fabricate curbs to minimum height of 12 inches (305 mm) above roofing surface unless otherwise indicated.
4. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange or by use of leveler frame.
5. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
6. Insulation: Factory insulated with 1-1/2-inch- (38-mm) thick glass-fiber board insulation.
7. Liner: Same material as curb, of manufacturer's standard thickness and finish.
8. Nailer: Factory-installed wood nailer along top flange of curb, continuous around curb perimeter.
9. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
10. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch (19-mm) thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
11. Metal Counter flashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.

2.3 EQUIPMENT SUPPORTS

A. Equipment Supports: Rail-type metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on Drawings, spanning between structural supports; capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, and integrally formed structure-mounting flange at bottom.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Supported Load Capacity: As required to support superimposed loads.

D. Material: Zinc-coated (galvanized) steel sheet, 0.052 inch (1.32 mm) thick.

1. Finish: Two-coat fluoropolymer.
2. Color: As selected by Architect from manufacturer's full range.

E. Construction:
1. Curb Profile: Manufacturer's standard compatible with roofing system.
2. Insulation: Factory insulated with 1-1/2-inch- (38-mm) thick glass-fiber board insulation.
3. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
4. Nailer: Factory-installed continuous wood nailers 3-1/2 inches (90 mm) wide on top flange of equipment supports, continuous around support perimeter.
5. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb of size and spacing required to meet wind uplift requirements.
6. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from 3/4-inch (19-mm) thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
7. Metal Counter flashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
8. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
9. Fabricate equipment supports to minimum height of 12 inches (305 mm) above roofing surface unless otherwise indicated.
10. Sloping Roofs: Where roof slope exceeds 1:48, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.

2.4 ROOF HATCH

A. Roof Hatches: Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counter flashing and weathertight perimeter gasketing, straight sides, and integrally formed deck-mounting flange at perimeter bottom.

B. Type and Size: Single-leaf lid, 30 inches by 36 inches clear interior, arranged and installed for compliance with IMC Section 306.5.

C. Loads: Minimum 40-lbf/sq. ft. (1.9-kPa) external live load and 20-lbf/sq. ft. (0.95-kPa) internal uplift load.

D. Hatch Material: Zinc-coated (galvanized) steel sheet.
1. Thickness: Manufacturer's standard thickness for hatch size indicated.
2. Finish: Two-coat fluoropolymer.
3. Color: As selected by Architect from manufacturer's full range.

E. Construction:
1. Insulation: Cellulosic-fiber board.
a. R-Value: 12.0 according to ASTM C 1363.

2. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
3. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
4. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
5. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
6. Fabricate curbs to minimum height of 12 inches (305 mm) above roofing surface unless otherwise indicated.
7. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is tapered to accommodate roof slope so that top surfaces of perimeter curb are level. Equip hatch with water diverter or cricket on side that obstructs water flow.

F. Hardware: Spring operators, hold-open arm, galvanized or stainless-steel spring latch with turn handles, galvanized or stainless-steel butt- or pintle-type hinge system, and padlock hasps inside and outside.

G. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder.
1. Operation: Post locks in place on full extension; release mechanism returns post to closed position.
2. Height: 42 inches (1060 mm) above finished roof deck.
3. Material: Steel tube.
4. Post: 1-5/8-inch- (41-mm) diameter pipe.
5. Finish: Manufacturer's standard baked enamel or powder coat.
   a. Color: As selected by Architect from manufacturer's full range.

2.5 METAL MATERIALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.
1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil (0.005 mm).
2. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil (0.013 mm).

B. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized according to ASTM A 123/A 123M unless otherwise indicated.

C. Steel Tube: ASTM A 500/A 500M, round tube.

D. Galvanized-Steel Tube: ASTM A 500/A 500M, round tube, hot-dip galvanized according to ASTM A 123/A 123M.

E. Steel Pipe: ASTM A 53/A 53M, galvanized.

2.6 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 1, thickness as indicated.

C. Glass-Fiber Board Insulation: ASTM C 726, nominal density of 3 lb/cu. ft. (48 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C), thickness as indicated.

D. Polyisocyanurate Board Insulation: ASTM C 1289, thickness and thermal resistivity as indicated.

E. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, and complying with AWPA C2; not less than 1-1/2 inches (38 mm) thick.

F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

G. Underlayment:
1. Felt: ASTM D 226/D 226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
2. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D 4397.
3. Slip Sheet: Building paper, 3 lb/100 sq. ft. (0.16 kg/sq. m) minimum, rosin sized.
4. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
5. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
6. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.

H. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

I. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

J. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

K. Asphalt Roofing Cement: ASTM D 4586/D 4586M, asbestos free, of consistency required for application.

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install roof accessories according to manufacturer's written instructions.
   1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
   2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
   3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
   4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
   1. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.

2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.

C. Roof Curb Installation: Install each roof curb so top surface is level.

D. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.

E. Roof-Hatch Installation:
1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
2. Attach safety railing system to roof-hatch curb.
3. Attach ladder-assist post according to manufacturer's written instructions.
4. Verify that locations of access and servicing points for roof-mounted equipment are served by locations of roof walkways.

F. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780/A 780M.

B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 09 91 13 - Exterior Painting.

C. Clean exposed surfaces according to manufacturer's written instructions.

D. Clean off excess sealants.

E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07 72 53
SNOW GUARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Rail-type, seam-mounted snow guards.

1.3 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for snow guards.

B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.
1. Include details of rail-type snow guards.
2. Include calculation of number and location of snow guards based on snow load, roof slope, roof type, components, spacing's and finish.

C. Samples: Base, bracket, and 12-inch- (300-mm-) long rail.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of snow guard, for tests performed by manufacturer and witnessed by a qualified testing agency.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

B. Structural Performance:
1. Snow Loads: As indicated Structural Design Criteria.

2.2 RAIL-TYPE SNOW GUARDS

A. Seam-Mounted, Rail-Type Snow Guards:

1. Available manufacturers: Manufacturers whose products may be incorporated into the project include but are not limited to the following:
    a. Alpine SnowGuards
    b. LMCurbs
    c. Sno-Gem, Inc.
    d. Snow Management Systems
    e. TRA Snow & Sun, Inc.
2. Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with two rails.
3. Material and Finish: Match metal roof panels, or as approved by Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.
    1. Verify compatibility with and suitability of substrates including compatibility with existing finishes or primers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare substrates for bonding snow guards.

B. Prime substrates according to snow guard manufacturer's written instructions.

3.3 INSTALLATION

A. Install snow guards according to manufacturer's written instructions. Space rows as indicated.

B. Attachment for Standing-Seam Metal Roofing:
    1. Do not use fasteners that will penetrate metal roofing, or fastening methods that void metal roofing finish warranty.
    2. Seam-Mounted, Rail-Type Snow Guards: Stainless-steel clamps attached to vertical ribs of standing-seam metal roof panels.

END OF SECTION

SECTION 07 92 00
JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes joint sealants for the following applications, including those specified by reference to this Section:
   1. Exterior joints in the following vertical surfaces and horizontal, non-traffic surfaces:
      a. Construction joints in cast-in-place concrete.
      b. Joints between metal panels.
      c. Joints between different materials listed above.
      d. Perimeter joints between materials listed above and frames of doors and louvers.
      e. Other joints as indicated.
   2. Exterior joints in the following horizontal traffic surfaces:
      a. Isolation and contraction joints in cast-in-place concrete slabs.
      b. Other joints as indicated.
   3. Interior joints in the following vertical surfaces and horizontal, non-traffic surfaces:
      a. Control and expansion joints on exposed interior surfaces of exterior walls.
      b. Perimeter joints of exterior openings where indicated.
      c. Other joints as indicated.
   4. Interior joints in the following horizontal traffic surfaces:
      a. Isolation joints in cast-in-place concrete slabs.
      b. Other joints as indicated.

1.3 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

D. Qualification Data: For Installer and testing agency.

E. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
   1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
   2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

F. Product Test Reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.

G. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
   1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
   2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
   3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
   5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

D. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period preceding the commencement of the Work.
   1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
   2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.

3. Test other joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.

1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
   2. When joint substrates are wet.
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Ten years from date of Substantial Completion.

C. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:
   1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
   2. Disintegration of joint substrates from natural causes exceeding design specifications.
   3. Mechanical damage caused by individuals, tools, or other outside agents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and

application, as demonstrated by sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1. Sealants: 250 g/L.
   2. Sealant Primers for Nonporous Substrates: 250 g/L.
   3. Sealant Primers for Porous Substrates: 775 g/L.

C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

C. Suitability for Contact with Food: Where elastomeric sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

D. Single-Component Mildew-Resistant Neutral-Curing Silicone Sealant ES-1:
   1. Available Products:
      a. Pecora Corporation; 898.
      b. Tremco; Tremsil 600 White.
   2. Type and Grade: S (single component) and NS (nonsag).
   3. Class: 25.
   4. Use Related to Exposure: NT (nontraffic).
   5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
      a. Use O Joint Substrates: ceramic tile.

E. Multicomponent Nonsag Urethane Sealant ES-2:
   1. Available Products:
      a. Pecora Corporation; Dynatrol II.
      b. Tremco; Dymeric 511.
      c. Tremco; Vulkem 922.
   2. Type and Grade: M (multicomponent) and NS (nonsag).
   3. Class: 50.
   4. Use[s] Related to Exposure: NT (nontraffic) and T (traffic).
   5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
      a. Use O Joint Substrates: galvanized steel, brick, ceramic tile and wood.

F. Multicomponent Pourable Urethane Sealant ES-3:
   1. Available Products:
      a. Pecora Corporation; Dynatrol II-SG.
      b. Sika Corporation, Inc.; Sikaflex - 2c SL.
      c. Sonneborn, Division of ChemRex Inc.; SL 2.
   2. Type and Grade: M (multicomponent) and P (pourable).
   3. Class: 25.
   4. Uses Related to Exposure: T (traffic) and NT (nontraffic).
   5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
      a. Use O Joint Substrates: ceramic tile.

2.4 LATEX JOINT SEALANTS

A. Latex Sealant LS-1: Comply with ASTM C 834, Type P, Grade NF.

B. Available Products:
   1. Bostik Findley; Chem-Calk 600.
   2. Pecora Corporation; AC-20+.
   3. Schnee-Morehead, Inc.; SM 8200.
   4. Sonneborn, Division of ChemRex Inc.; Sonolac.
   5. Tremco; Tremflex 834.

2.5 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), O (open-cell material), B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.6 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of

staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.
3. Remove laitance and form-release agents from concrete.
4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.

D. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

F. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

G. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
   4. Provide flush joint configuration where indicated per Figure 5B in ASTM C 1193.
   5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 5C in ASTM C 1193.
      a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION

SECTION 07 92 19
ACOUSTICAL JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes acoustical joint sealants.

B. Related Requirements:
1. Section 07 92 00 "Joint Sealants" for elastomeric, latex, and butyl-rubber-based joint sealants for non-acoustical applications.

1.3 ACTION SUBMITTALS

A. Product Data: For each acoustical joint sealant.

B. LEED Submittals:

C. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

D. Samples for Verification: For each kind and color of acoustical joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

E. Acoustical-Joint-Sealant Schedule: Include the following information:
1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each kind of acoustical joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.

B. Sample Warranties: For special warranties.

1.5 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace acoustical joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish acoustical joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies according to ASTM E 90.

B. VOC Content of Interior Sealants: Sealants and sealant primers shall comply with the following:
   1. Acoustical sealants and sealant primers shall have a VOC content of 250 g/L or less.

C. Low-Emitting Interior Sealants: Acoustical sealants and sealant primers shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.2 ACOUSTICAL JOINT SEALANTS

A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C 834.
   1. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range of colors.

2.3 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by acoustical-joint-sealant manufacturer where required for adhesion of sealant to joint substrates.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive acoustical joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where recommended by acoustical-joint-sealant manufacturer. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF ACOUSTICAL JOINT SEALANTS

A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.

B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C 919, ASTM C 1193, and manufacturer's written recommendations for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.

C. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of acoustical joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect acoustical joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or

other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated acoustical joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION

DIVISION 08
OPENINGS

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SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Standard hollow metal doors and frames.

B. Related Sections:
   1. Division 08 Section "Door Hardware" for door hardware for hollow metal doors.
   2. Division 09 Sections "Exterior Painting" and "Interior Painting" for field painting hollow metal doors and frames.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, temperature-rise ratings, and finishes.

B. Shop Drawings: Include the following:
   1. Elevations of each door design.
   2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
   3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   4. Locations of reinforcement and preparations for hardware.
   5. Details of each different wall opening condition.
   6. Details of anchorages, joints, field splices, and connections.
   7. Details of accessories.
   8. Details of moldings and removable stops.

C. Other Action Submittals:
   1. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.

D. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure.
   1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
   2. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.

C. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch- (102-mm-) high wood blocking. Do not store in a manner that traps excess humidity.
   1. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Ceco Door Products; an Assa Abloy Group company.
   2. Fleming Door Products Ltd.; an Assa Abloy Group company.
   3. Kewanee Corporation (The).
   4. Steelcraft; an Ingersoll-Rand company.
   5. Curries : an Assa Abloy company

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

E. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

F. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. (96- to 192-kg/cu. m) density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

G. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

H. Glazing: Comply with requirements in Section 08 80 00 - Glazing.

2.3 STANDARD HOLLOW METAL DOORS

A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.
   1. Design: Flush panel.
   2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.

a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
b. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W) when tested according to ASTM C 1363.
1) Locations: Interior doors between tempered and non-tempered spaces, and all exterior doors.

3. Vertical Edges for Single-Acting Doors: Manufacturer's standard.
4. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- (1.0-mm-) thick, end closures or channels of same material as face sheets.
5. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

B. Exterior and Interior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
1. Level 2 and Physical Performance Level B (Heavy Duty), Model 1 (Full Flush).

C. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

D. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.4 STANDARD HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Exterior and Interior Frames: Fabricated from metallic-coated steel sheet.
1. Fabricate frames with mitered or coped corners.
2. Fabricate frames as full profile welded unless otherwise indicated.
3. Frames for Level 2 Steel Doors: 0.053-inch (16 ga) thick steel sheet.

C. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches (610 mm) of frame height above 7 feet (2.1 m).
3. Postinstalled Expansion Anchor: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M; hot-dip galvanized according to ASTM A 153/A 153M, Class B.

2.6 STOPS AND MOLDINGS

A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch (0.8 mm) thick, fabricated from same material as door face sheet in which they are installed.

B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated.

C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch (0.8 mm) thick, fabricated from same material as frames in which they are installed.

2.7 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/NAAMM-HMMA 861.

C. Hollow Metal Doors:
1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
2. Glazed Lites: Factory cut openings in doors.
3. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted.

D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Sidelight Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
2. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.

3. Jamb Anchors: Provide number and spacing of anchors as follows:
    a. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
        1) Three anchors per jamb up to 60 inches (1524 mm) high.
        2) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
        3) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
        4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.
        5) Two anchors per head for frames above 42 inches (1066 mm) wide and mounted in metal-stud partitions.
    b. Compression Type: Not less than two anchors in each jamb.
4. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.
    a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
1. Locate hardware as indicated, or if not indicated, according to ANSI/NAAMM-HMMA 861.
2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

G. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
2. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
3. Provide loose stops and moldings on inside of hollow metal work.
4. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.8 STEEL FINISHES

A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

B. Final Painting: Shop and/or field paint all doors and steel hollow metal frames in finish colors to match colors selected by Architect. Coordinate with Division 09 painting sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:
1. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
2. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
3. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
    a. At fire-protection-rated openings, install frames according to NFPA 80.
    b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    c. Install frames with removable glazing stops located on secure side of opening.
    d. Install door silencers in frames before grouting.
    e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    g. Field apply bituminous coating to backs of frames that are filled with grout containing anti-freezing agents.
2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
4. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
    a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
1. Non-Fire-Rated Standard Steel Doors:
    a. Jambs and Head: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
    b. Between Edges of Pairs of Doors: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
    c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch (9.5 mm).
    d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch (19 mm).
2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors according to NFPA 105.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
   1. If doors or frames shop painted, also smooth & touch-up finished paint coats.

D. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION

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SECTION 08 14 16
FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Solid-core doors with wood-veneer faces.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of door. Include factory-finishing specifications.
1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Chain-of-Custody Qualification Data: For manufacturer and vendor.
3. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
4. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
5. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
6. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:
1. Dimensions and locations of blocking.
2. Dimensions and locations of mortises and holes for hardware.
3. Dimensions and locations of cutouts.
4. Undercuts.
5. Requirements for veneer matching.
6. Doors to be factory finished and finish requirements.
7. Fire-protection ratings for fire-rated doors.

C. Samples: For factory-finished doors.

1.3 INFORMATIONAL SUBMITTALS

A. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. ABS- American Building Supply- Doormerica.
   2. Marshfield DoorSystems, Inc.
   3. Mohawk Flush Doors, Inc.
   4. Oshkosh Door Company.
   5. VT Industries Inc.

2.2 FLUSH WOOD DOORS, GENERAL

A. Quality Standard: In addition to requirements specified, comply with AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."
   1. Provide AWI Quality Certification Labels indicating that doors comply with requirements of grades specified.

B. Regional Materials: Wood doors shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

C. Regional Materials: Wood doors shall be manufactured within 500 miles (800 km) of Project site.

D. Certified Wood: Wood doors shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-00 and FSC STD-40-004.

E. Adhesives: Do not use adhesives that contain urea formaldehyde.

F. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

G. Composite Wood Products: Products shall be made without urea formaldehyde.

H. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

I. WDMA I.S.1-A Performance Grade:
   1. Heavy Duty unless otherwise indicated.
   2. Extra Heavy Duty: Classrooms public toilets janitor's closets assembly spaces exits and where indicated.
   3. Standard Duty: Closets (not including janitor's closets) and where indicated.

J. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
   1. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
   2. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
   3. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.

K. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing according to UL 1784.

L. Particleboard-Core Doors:
   1. Particleboard: ANSI A208.1, Grade LD-1 or Grade LD-2 , made with binder containing no urea-formaldehyde.
   2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
   3. Provide doors with glued-wood-stave or structural-composite-lumber cores instead of particleboard cores for doors indicated to receive exit devices.

M. Structural-Composite-Lumber-Core Doors:
   1. Structural Composite Lumber: WDMA I.S.10.
      a. Screw Withdrawal, Face: 700 lbf (3100 N).
      b. Screw Withdrawal, Edge: 400 lbf (1780 N).

N. Mineral-Core Doors:
   1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
   2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
   3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

O. Hollow-Core Doors:
   1. Construction: Standard hollow core.

2.3 VENEER-FACED DOORS FOR TRANSPARENT FINISH
   1.

A. Interior Solid-Core Doors:
   1. Grade: Custom (Grade A faces).
   2. Species: Select red birch.
   3. Cut: Rotary cut.
   4. Match between Veneer Leaves: Slip match.

5. Assembly of Veneer Leaves on Door Faces: Balance match.
6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
7. Core: Either glued or nonglued wood stave or structural composite lumber.
8. Construction: Five plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering. Faces are bonded to core using a hot press.

2.4 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
   1. Comply with NFPA 80 requirements for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied.

C. Openings: Factory cut and trim openings through doors.
   1. Light Openings: Trim openings with moldings of material and profile indicated.
   2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."
   3. Louvers: Factory install louvers in prepared openings.

2.5 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
   1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.

B. Factory finish doors that are indicated to receive transparent finish.

C. Transparent Finish:
   1. Grade: Custom.
   2. Finish: AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" System 9, UV curable, acrylated epoxy, polyester, or urethane.
   3. Staining: Match Architect's sample.
   4. Effect: Filled finish.
   5. Sheen: Semigloss.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hardware: For installation, see Section 087100 "Door Hardware."

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
   1. Install fire-rated doors according to NFPA 80.
   2. Install smoke- and draft-control doors according to NFPA 105.

C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.

1. Clearances: Provide 1/8 inch (3.2 mm) at heads, jambs, and between pairs of doors. Provide 1/8 inch (3.2 mm) from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch (6.4 mm) from bottom of door to top of threshold unless otherwise indicated.
    a. Comply with NFPA 80 for fire-rated doors.

D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

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SECTION 08 31 13
ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes access doors and frames for walls and ceilings.

B. Related Requirements:
1. Section 07 72 00 "Roof Accessories" for roof hatches.
2. Section 23 31 00 "Ductwork" for heating and air-conditioning duct access doors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, fire ratings, material descriptions, dimensions of individual components and profiles, and finishes.

B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum 6 by 6 inches (150 by 150 mm) in size.

C. Product Schedule: For access doors and frames. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection and temperature-rise limit ratings indicated, according to NFPA 252 or UL 10B.

2.2 ACCESS DOORS AND FRAMES

A. Flush Access Doors with Exposed Flanges:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Acudor Products, Inc.
b. Babcock-Davis.
c. Cendrex Inc.

d. Elmdor/Stoneman Manufacturing Company; a division of Acorn Engineering Company.
e. JL Industries, Inc.; a division of the Activar Construction Products Group.
f. Karp Associates, Inc.
g. Lane-Aire Manufacturing Corp.
h. Larsens Manufacturing Company.
i. Maxam Metal Products Limited.
j. Metropolitan Door Industries Corp.
k. MIFAB, Inc.
l. Milcor; Commercial Products Group of Hart & Cooley, Inc.
m. Nystrom, Inc.
n. Williams Bros. Corporation of America (The).

2. Description: Face of door flush with frame, with exposed flange and concealed hinge.
3. Locations: Wall and ceiling.
4. Door Size: 3'-4" x 3'-4".
5. Uncoated Steel Sheet for Door: Nominal 0.060 inch (1.52 mm), 16 gage, factory finished.
6. Frame Material: Same material, thickness, and finish as door.
7. Latch and Lock: Cam latch, hex-head wrench operated.

2.3 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

D. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304. Remove tool and die marks and stretch lines, or blend into finish.

E. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063.

F. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

G. Frame Anchors: Same material as door face.

H. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.4 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
   1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
   2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded-metal lath and exposed casing bead welded to perimeter of frames.

D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling. Provide access sleeves for each latch operator and install in holes cut through finish.
   1. For recessed doors with plaster infill, provide self-furring expanded-metal lath attached to door panel.

E. Latch and Lock Hardware:
   1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
   2. Keys: Furnish two keys per lock and key all locks alike.
   3. Mortise Cylinder Preparation: Where indicated, prepare door panel to accept cylinder specified in Section 08 71 00 "Door Hardware."

F. Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.5 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
   2. Factory Finished: Apply manufacturer's standard baked-enamel or powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of 1 mil (0.025 mm) for topcoat.
      a. Color: As selected by Architect from full range of industry colors.

E. Stainless-Steel Finishes:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finish: No. 4 finish. Grind and polish surfaces to produce uniform finish, free of cross scratches.
    a. Run grain of directional finishes with long dimension of each piece.
    b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
3. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION

SECTION 08 33 23
OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Insulated service doors.

B. Related Requirements:
   1. Section 05 50 00 "Metal Fabrications" for miscellaneous steel supports, door-opening framing, corner guards, and bollards.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory.
   1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
   4. For exterior components, include details of provisions for assembly expansion and contraction and for excluding and draining moisture to the exterior.
   5. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.
   1. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:
   1. Curtain slats, including full vision window secured to slat.
   2. Include similar Samples of accessories involving color selection.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing and inspecting agency.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Special warranty.

B. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

C. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.
   1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of doors that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.
   1. Obtain operators and controls from overhead coiling-door manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Structural Performance, Exterior Doors: Capable of withstanding the following design wind loads:
   1. Design Wind Load: As indicated on Drawings.
   2. Testing: According to ASTM E330/E330M.
   3. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.
   4. Operability under Wind Load: Design overhead coiling doors to remain operable under uniform pressure (velocity pressure) of 20-lbf/sq. ft. (960-Pa) wind load, acting inward and outward.

B. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. Component Importance Factor: 1.0.

2.3 DOOR ASSEMBLY

A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ACME Rolling Doors.
      b. Advanced Door Technologies.
      c. Alpine Overhead Doors, Inc.
      d. Cookson; a CornellCookson company.
      e. Cornell; a CornellCookson company.
      f. McKeon Rolling Steel Door Company, Inc.
      g. Overhead Door Corporation.
      h. Wayne-Dalton Corp.

B. Operation Cycles: Door components and operators capable of operating for not less than 50,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

C. Air Infiltration: Maximum rate of 1.0 cfm/sq. ft. (5.1 L/s per sq. m) at 15 and 25 mph (24.1 and 40.2 km/h) when tested according to ASTM E283.

D. Insulated Door Curtain R-Value: 4.5 deg F x h x sq. ft./Btu (0.792 K x sq. m/W).

E. Insulated Door Assembly U-Factor: 0.90 Btu/deg F x h x sq. ft. (5.1 W/K x sq. m).

F. Door Curtain Material: Galvanized steel or Aluminum.

G. Door Curtain Slats: Flat profile slats of 2-5/8-inch (67-mm) to 3-1/4-inch (83-mm) center-to-center height.
   1. Vision Panels: Approximately 10- by 1-5/8-inch (254- by 41-mm) openings spaced approximately 2 inches (51 mm) apart and beginning 12 inches (305 mm) from end guides; in three rows of slats as approved by Owner; installed with insulated vision-panel glazing.
   2. Gasket Seal. Manufacturer's standard continuous gaskets between slats.

H. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch (38 by 38 by 3 mm) thick; fabricated from hot-dip galvanized steel and finished to match door.

I. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.

J. Hood: Match curtain material and finish.
   1. Shape: Round or Square.
   2. Mounting: Face of wall.

K. Locking Devices: Equip door with locking device assembly.

1. Locking Device Assembly: Single-jamb side locking bars, operable from inside with thumbturn.

L. Electric Door Operator:
1. Usage Classification: Standard duty, up to 25 cycles per hour and up to 90 cycles per day.
2. Operator Location: Manufacturer's standard interior, easily accessible for maintenance.
3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use; moving parts of operator enclosed or guarded if exposed and mounted at 8 ft. (2.44 m) or lower.
4. Motor Exposure: Interior.
5. Motor Electrical Characteristics:
   a. Horsepower: As recommended by manufacturer for door size and usage.
   b. Voltage: 208 V ac, single phase, 60 Hz.
6. Emergency Manual Operation: Chain type.
7. Obstruction-Detection Device: Any of the following as recommended by the door manufacturer and in accordance with its listing: Automatic photoelectric sensor; electric sensor edge on bottom bar; pneumatic sensor edge on bottom bar; self-monitoring type.
   a. Sensor Edge Bulb Color: Black.
8. Control Station(s): Interior mounted.
9. Other Equipment: Audible and visual signals.

M. Curtain Accessories: Equip door with weatherseals.

N. Door Finish:
1. Baked-Enamel or Powder-Coated Finish: Color as selected by Architect from manufacturer's full range.
2. Factory Prime Finish: Manufacturer's standard color.
3. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

2.4 MATERIALS, GENERAL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural-steel sheet; complying with ASTM A653/A653M, with G90 (Z275) zinc coating; nominal sheet thickness (coated) of 0.028 inch (0.71 mm); and as required.

2. Aluminum Door Curtain Slats: ASTM B209 (ASTM B209M) sheet or ASTM B221 (ASTM B221M) extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; thickness of 0.050 inch (1.27 mm); and as required.
3. Vision-Panel Glazing: Manufacturer's standard clear glazing, fabricated from transparent acrylic sheet or fire-protection-rated glass as required for type of door; set in glazing channel secured to curtain slats.
4. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E84 or UL 723. Enclose insulation completely within slat faces.
5. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face, with minimum steel thickness of 0.010 inch (0.25 mm) and minimum aluminum thickness of 0.032 inch (0.80 mm) (as applicable).

2.6 HOODS

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
1. Galvanized Steel: Nominal 0.028-inch- (0.71-mm-) thick, hot-dip galvanized-steel sheet with G90 (Z275) zinc coating, complying with ASTM A653/A653M.
2. Aluminum: 0.040-inch- (1.02-mm-) thick aluminum sheet complying with ASTM B209 (ASTM B209M), of alloy and temper recommended by manufacturer and finisher for type of use and finish indicated.

2.7 LOCKING DEVICES

A. Locking Device Assembly: Fabricate with thumb-turn, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

B. Chain Lock Keeper: Suitable for padlock.

C. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.8 CURTAIN ACCESSORIES

A. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.
1. At door head, use 1/8-inch- (3-mm-) thick, replaceable, continuous-sheet baffle secured to inside of hood or field-installed on the header.
2. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch- (3-mm-) thick seals of flexible vinyl, rubber, or neoprene.

2.9 COUNTERBALANCE MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, seamless or welded carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. (2.5 mm/m) of span under full load.

C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.10 ELECTRIC DOOR OPERATORS

A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
   1. Comply with NFPA 70.
   2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.

B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.

C. Door Operator Location(s): Operator location shall be consistent for all doors, but may be either of the following:
   1. Front-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
   2. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall-mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.

D. Motors: Reversible-type motor for motor exposure indicated for each door assembly.

1. Electrical Characteristics: Large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor.
2. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
3. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.

E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

F. Obstruction-Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.
1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
    a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained or constant pressure on close button.
2. Electric Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.
3. Pneumatic Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device.

G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."
1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.

H. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf (111 N).

I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

K. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with the accessibility standard.

2.11 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.12 ALUMINUM FINISHES

A. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Examine locations of electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Install overhead coiling doors, hoods, controls, and operators at the mounting locations indicated for each door.

C. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with the accessibility standard.

D. Power-Operated Doors: Install according to UL 325.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and to furnish reports to Architect.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Test door release, closing, and alarm operations when activated by smoke detector or building's fire-alarm system. Test manual operation of closed door. Reset door-closing mechanism after successful test.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. After electrical circuitry has been energized, operate doors to confirm proper motor rotation and door performance.
   3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.5 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
   1. Adjust exterior doors and components to be weather resistant.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust seals to provide tight fit around entire perimeter.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION

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SECTION 08 36 13
SECTIONAL DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes electrically operated sectional doors.

B. Related Requirements:
   1. Section 05 50 00 "Metal Fabrications" for miscellaneous steel supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of sectional door and accessory.
   1. Include construction details, material descriptions, dimensions of individual components, profile door sections, and finishes.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. Product Data for Credit MR 4.0: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content.

C. Product Data for Credit EQ 4.1: Product data for adhesives and sealants used inside the weatherproofing system indicating VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   1. Include statement indicating manufacturer's name, product name, and specific VOC data (in g/L, less water) for each product.

D. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
   4. Include diagrams for power, signal, and control wiring.

E. Samples for Initial Selection: For units with factory-applied finishes.
   1. Include Samples of accessories involving color selection.

F. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:

1. Flat door sections.
2. Frame for paneled door sections; of each width of stile and rail required.
3. Panel for raised-panel door sections; not smaller than required to show profile.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sectional doors to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC A117.1.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
a. Structural failures including, but not limited to, excessive deflection.
b. Failure of components or operators before reaching required number of operation cycles.
c. Faulty operation of hardware.
d. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use; rust through.
e. Delamination of exterior or interior facing materials.
2. Warranty Period: Five years from date of Substantial Completion.

B. Special Finish Warranty: Manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.
1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS, GENERAL

A. Source Limitations: Obtain sectional doors from single source from single manufacturer.
1. Obtain operators and controls from sectional door manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Sectional doors shall comply with performance requirements specified without failure due to defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.

B. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.
   1. Design Wind Load: As indicated on Drawings.
   2. Testing: According to ASTM E 330 or DASMA 108 for garage doors and complying with the acceptance criteria of DASMA 108.
   3. Deflection Limits: Design sectional doors to withstand design wind loads without evidencing permanent deformation or disengagement of door components.
      a. Deflection of door sections in horizontal position (open) shall not exceed 1/120 of the door width.
      b. Deflection of horizontal track assembly shall not exceed 1/240 of the door height.
   4. Operability under Wind Load: Design overhead coiling doors to remain operable under design wind load, acting inward and outward.

C. Windborne-Debris Impact Resistance: Provide sectional doors that pass missile-impact and cyclic-pressure tests according to ASTM E 1996 for Wind Zone 2.

D. Seismic Performance: Sectional doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. Component Importance Factor: As indicated.

2.3 DOOR ASSEMBLY

A. Steel Sectional Overhead Door: Sectional door formed with hinged sections and fabricated according to DASMA 102 unless otherwise indicated.

B. Operation Cycles: Door components and operators capable of operating for not less than 20,000 cycles. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

C. Air Infiltration: Maximum rate of 0.08 cfm/sq. ft. (0.406 L/s per sq. m) at 15 and 25 mph (24.1 and 40.2 km/h) when tested according to ASTM E 283 or DASMA 105.

D. Minimum Installed R-Value: 7.0 deg F x h x sq. ft./Btu.

E. Steel Sections: Zinc-coated (galvanized) steel sheet with G90 (Z275) zinc coating.
   1. Section Thickness: 2 inches (51 mm).
   2. Exterior-Face, Steel Sheet Thickness: 0.064-inch- (1.63-mm-) nominal coated thickness.
      a. Surface: Flat.
   3. Insulation: Board or Foamed in place.
   4. Interior Facing Material: Zinc-coated (galvanized) steel sheet with a nominal coated thickness of manufacturer's recommended dimension to comply with performance requirements.

F. Track Configuration: Low-overhead horizontal track.

G. Weather-seals: Fitted to bottom and top and around entire perimeter of door. Ensure that bottom sensor edge is combined with or does not compromise function of bottom weather-seal.

H. Windows: Approximately 24 by 7 inches (610 by 178 mm) with square corners and spaced apart the approximate distance as indicated on Drawings; in two row(s) at height indicated on Drawings; installed with glazing of the following type:
1. Insulating Glass: Manufacturer's standard.

I. Roller-Tire Material: Manufacturer's standard.

J. Locking Devices: Equip door with locking device assembly.
1. Locking Device Assembly: Single-jamb side locking bars, operable from inside with thumb-turn.

K. Counterbalance Type: Torsion spring.

L. Electric Door Operator:
1. Usage Classification: Light duty, up to 10 cycles per hour.
2. Operator Type: Manufacturer's standard side-mounted operator for door requirements.
3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use; moving parts of operator enclosed or guarded if exposed and mounted at 8 feet (2.4 m) or lower.
4. Motor Exposure: Interior, clean, and dry
5. Emergency Manual Operation: Chain type.
6. Obstruction-Detection Device: Manufacturer's standard.
   a. Sensor Edge Bulb Color: Black.
7. Control Station: Interior-side mounted.

M. Door Finish:
1. Baked-Enamel or Powder-Coat Finish: Color and gloss as selected by Architect from manufacturer's full range.
2. Finish of Interior Facing Material: Finish as selected by Architect from manufacturer's full range.

2.4 MATERIALS, GENERAL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 STEEL DOOR SECTIONS

A. Exterior Section Faces and Frames: Zinc-coated (galvanized), cold-rolled, commercial steel (CS) sheet, complying with ASTM A 653/A 653M, with indicated zinc coating and thickness.
1. Fabricate section faces from single sheets to provide sections not more than 24 inches (610 mm) high and of indicated thickness. Roll horizontal meeting edges to a

continuous, interlocking, keyed, rabbeted, shiplap, or tongue-in-groove weather-resistant seal, with a reinforcing flange return.

2. For insulated doors, provide sections with continuous thermal-break construction, separating the exterior and interior faces of door.

B. Section Ends and Intermediate Stiles: Enclose open ends of sections with channel end stiles formed from galvanized-steel sheet not less than 0.064-inch- (1.63-mm-) nominal coated thickness and welded to door section. Provide intermediate stiles formed from not less than 0.064-inch- (1.63-mm-) thick galvanized-steel sheet, cut to door section profile, and welded in place. Space stiles not more than 48 inches (1219 mm) apart.

C. Reinforce bottom section with a continuous channel or angle conforming to bottom-section profile.

D. Reinforce sections with continuous horizontal and diagonal reinforcement, as required to stiffen door and for wind loading. Provide galvanized-steel bars, struts, trusses, or strip steel, formed to depth and bolted or welded in place. Ensure that reinforcement does not obstruct vision lites.

E. Provide reinforcement for hardware attachment.

F. Board Thermal Insulation: Insulate interior of steel sections with door manufacturer's standard CFC-free polystyrene or polyurethane board insulation, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84; or with glass-fiber-board insulation. Secure insulation to exterior face sheet. Enclose insulation completely within steel sections and the interior facing material, with no exposed insulation.

G. Foamed-in-Place Thermal Insulation: Insulate interior of steel sections with door manufacturer's standard CFC-free polyurethane insulation, foamed in place to completely fill interior of section and pressure bonded to face sheets to prevent delamination under wind load, and with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within steel sections and the interior facing material, with no exposed insulation.

H. Interior Facing Material: Manufacturer's standard material complying with the acceptance criteria of DASMA 107, with indicated thickness.

I. Fabricate sections so finished door assembly is rigid and aligned, with tight hairline joints and free of warp, twist, and deformation.

2.6 TRACKS, SUPPORTS, AND ACCESSORIES

A. Tracks: Manufacturer's standard, galvanized-steel track system of configuration indicated, sized for door size and weight, designed for lift type indicated and clearances indicated on Drawings. Provide complete system as required to meet low-overhead-clearance conditions, including brackets, bracing, and reinforcement to ensure rigid support of ball-bearing roller guides for required door type, size, weight, and loading.

1. Galvanized Steel: ASTM A 653/A 653M, minimum G60 (Z180) zinc coating.
2. Slope tracks at an angle from vertical or design tracks to ensure tight closure at jambs when door unit is closed.

3. Track Reinforcement and Supports: Galvanized-steel members to support track without sag, sway, and vibration during opening and closing of doors. Slot vertical sections of track spaced 2 inches (51 mm) apart for door-drop safety device.
   a. For Vertical Track: Intermittent, jamb brackets attached to track and attached to wall.
   b. For Horizontal Track: Continuous reinforcing angle from curve in track to end of track, attached to track and supported at points by laterally braced attachments to overhead structural members.

B. Weather-seals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom and top of sectional door unless otherwise indicated.

C. Windows: Manufacturer's standard window units of type, size, and in arrangement indicated. Set glazing in vinyl, rubber, or neoprene glazing channel for metal-framed doors, as required. Provide removable stops of same material as door-section frames.

2.7 HARDWARE

A. General: Heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless-steel, or other corrosion-resistant fasteners, to suit door type.

B. Hinges: Heavy-duty, galvanized-steel hinges of not less than 0.079-inch- (2.01-mm-) nominal coated thickness at each end stile and at each intermediate stile, according to manufacturer's written recommendations for door size. Attach hinges to door sections through stiles and rails with bolts and lock nuts or lock washers and nuts. Use rivets or self-tapping fasteners where access to nuts is impossible. Provide double-end hinges where required, for doors more than 16 feet (4.88 m) wide unless otherwise recommended by door manufacturer.

C. Rollers: Heavy-duty rollers with steel ball-bearings in case-hardened steel races, mounted with varying projections to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Provide 3-inch- (76-mm-) diameter roller tires for 3-inch- (76-mm-) wide track and 2-inch- (51-mm-) diameter roller tires for 2-inch- (51-mm-) wide track.

D. Push/Pull Handles: Equip each push-up operated or emergency-operated door with galvanized-steel lifting handles on each side of door, finished to match door.

2.8 LOCKING DEVICES

A. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded deadbolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
   1. Lock Cylinders: Cylinders specified in Section 08 71 00 "Door Hardware" and keyed to building keying system.
   2. Keys: Six for each cylinder.

B. Chain Lock Keeper: Suitable for padlock.

C. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.9 COUNTERBALANCE MECHANISM

A. Torsion Spring: Counterbalance mechanism consisting of adjustable-tension torsion springs fabricated from steel-spring wire complying with ASTM A 229/A 229M, mounted on torsion shaft made of steel tube or solid steel. Provide springs designed for number of operation cycles indicated.

B. Cable Drums and Shaft for Doors: Cast-aluminum or gray-iron casting cable drums mounted on torsion shaft and grooved to receive door-lifting cables as door is raised. Mount counterbalance mechanism with manufacturer's standard ball-bearing brackets at each end of torsion shaft. Provide one additional midpoint bracket for shafts up to 16 feet (4.88 m) long and two additional brackets at one-third points to support shafts more than 16 feet (4.88 m) long unless closer spacing is recommended by door manufacturer.

C. Cables: Galvanized-steel, multi-strand lifting cables with cable safety factor of at least 7 to 1.

D. Cable Safety Device: Include a spring-loaded steel or spring-loaded bronze cam mounted to bottom door roller assembly on each side and designed to automatically stop door if either lifting cable breaks.

E. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.

F. Bumper: Provide spring bumper at each horizontal track to cushion door at end of opening operation.

2.10 ELECTRIC DOOR OPERATORS

A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and "operation cycles" requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
   1. Comply with NFPA 70.
   2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6; with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.

B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.

C. Door-Operator Type: Unit consisting of electric motor, gears, pulleys, belts, sprockets, chains, and controls needed to operate door and meet required usage classification.

D. Motors: Reversible-type motor for motor exposure indicated.
   1. Electrical Characteristics: 208V, single-phase.
   2. Motor Size: Large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor.
   3. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.

4. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
5. Use adjustable motor-mounting bases for belt-driven operators.

E. Limit Switches: Equip motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

F. Obstruction Detection Device: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. Activation of device immediately stops and reverses downward door travel.
1. Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.

G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure, push-button control labeled "Close."
1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.

H. Emergency Manual Operation: Equip electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf (111 N)

I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

K. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.

2.11 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.12 STEEL AND GALVANIZED-STEEL FINISHES

A. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Examine locations of electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Tracks:
1. Fasten vertical track assembly to opening jambs and framing, spaced not more than 24 inches (610 mm) apart.
2. Hang horizontal track assembly from structural overhead framing with angles or channel hangers attached to framing by welding or bolting, or both. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.

C. Accessibility: Install sectional doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

D. Power-Operated Doors: Install automatic garage doors openers according to UL 325.

3.3 STARTUP SERVICES

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust doors and seals to provide weather-resistant fit around entire perimeter.

D. Touch-up Painting: Immediately after welding galvanized materials, clean welds and abraded galvanized surfaces and repair galvanizing to comply with ASTM A 780/A 780M.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain sectional doors.

END OF SECTION

SECTION 08 41 13
ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Exterior and interior storefront framing.
2. Storefront framing for window walls.
3. Storefront framing for punched openings.
4. Exterior and interior manual-swing entrance doors and door-frame units.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components with profiles, and finishes.

B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
a. Joinery, including concealed welds.
b. Anchorage.
c. Expansion provisions.
d. Glazing.
e. Flashing and drainage.
3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

D. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch (300-mm) lengths of full-size components and showing details of the following:
1. Joinery, including concealed welds.
2. Anchorage.
3. Expansion provisions.
4. Glazing.
5. Flashing and drainage.

E. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

F. Delegated-Design Submittal: For aluminum-framed entrances and storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.
   1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront.

C. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C 1401. Include periodic quality-control reports.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.

B. Maintenance Data for Structural Sealant: For structural-sealant-glazed storefront to include in maintenance manuals. Include ASTM C 1401 recommendations for post-installation-phase quality-control program.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.

C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are

indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

D. Structural-Sealant Glazing: When this option is chosen for blast resistance, comply with ASTM C 1401 for design and installation of storefront systems.

1.7 MOCKUPS

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical wall area as shown on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION LABORATORY MOCKUPS

A. Preconstruction Testing Service: Engage a qualified testing agency to perform testing on preconstruction laboratory mockups.

B. Build preconstruction laboratory mockups at testing agency facility; use personnel, products, and methods of construction that will be used at Project site.

1. Size and Configuration: As needed to complete testing specified.
2. Notify Architect seven days in advance of the dates and times when preconstruction laboratory mockups will be constructed and tested.

C. Preconstruction Laboratory Mockup Testing Program: Test preconstruction laboratory mockups according to requirements in "Performance Requirements" Article. Perform the following tests in the following order:

1. Structural: ASTM E 330 at 50 percent of positive test load.
2. Air Infiltration: ASTM E 283.
3. Water Penetration under Static Pressure: ASTM E 331.
4. Water Penetration under Dynamic Pressure: AAMA 501.1.
5. Structural: ASTM E 330 at 100 percent of positive and negative test loads. Repeat the following:
    a. Air Infiltration: ASTM E 283.
    b. Water Penetration under Static Pressure: ASTM E 331.
6. Thermal Cycling: According to AAMA 501.5. Repeat the following:
    a. Air Infiltration: ASTM E 283.
    b. Water Penetration under Static Pressure: ASTM E 331.
7. Structural: ASTM E 330 at 100 and 150 percent of positive and negative test loads. Repeat the following:
    a. Air Infiltration: ASTM E 283.
    b. Water Penetration under Static Pressure: ASTM E 331.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Noise or vibration created by wind and thermal and structural movements.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      d. Water penetration through fixed glazing and framing areas.
      e. Failure of operating components.
   2. Warranty Period: Five years from date of Substantial Completion.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
      d. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 45 00 "Quality Control," to design aluminum-framed entrances and storefronts.

B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure including, but not limited to twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
   2. Failure also includes the following:
      a. Thermal stresses transferring to building structure.
      b. Glass breakage.
      c. Noise or vibration created by wind and thermal and structural movements.
      d. Loosening or weakening of fasteners, attachments, and other components.

C. Structural Loads:
   1. Wind Loads: As indicated on Drawings.
   2. Other Design Loads: As indicated on Drawings.

D. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limit framing members to 1/175 for spans less than or equal to 13'-6", and 1/240 plus 1/4" for spans greater than 13'-6". Framing deflection shall also be limited to restrict edge deflection of individual glazing lites to no more than 3/4 inch (19.1 mm).
2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.
3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
    a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4 inch (6.35 mm).
4. Vertical Deflection Accommodation: Exterior glass framing connections to structure shall accommodate 1/2" of vertical structural deflection to avoid imposing axial load into glazing.

E. Structural: Test according to ASTM E 330 as follows:
1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
1. Fixed Framing and Glass Area:
    a. Maximum air leakage of 0.06 cfm/sq. ft. (0.30 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
2. Entrance Doors:
    a. Pair of Doors: Maximum air leakage of 1.0 cfm/sq. ft. (5.08 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
    b. Single Doors: Maximum air leakage of 0.5 cfm/sq. ft. (2.54 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).

G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).

H. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
2. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

I. Seismic Performance: Aluminum-framed entrances and storefronts shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.6 at design displacement and 1.5 times the design displacement.

J. Energy Performance: Certify and label energy performance according to NFRC as follows:
   1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K) as determined according to NFRC 100.
   2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than amount specified in Division 8 Section, "Glazing."
   3. Condensation Resistance: As specified in Division 8 Section, "Aluminum Window Blast Requirements."

K. Noise Reduction: Test according to ASTM E 90, with ratings determined by ASTM E 1332, as follows.
   1. Outdoor-Indoor Transmission Class: Minimum 26.

L. Windborne-Debris Impact Resistance: As specified in Division 8 Section, "Aluminum Window Blast Requirements."

M. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
   1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
   2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
      a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).
      b. Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C).
      c. Interior Ambient-Air Temperature: 75 deg F (24 deg C).

N. Structural-Sealant Joints:
   1. Designed to carry gravity loads of glazing.
   2. Designed to produce tensile or shear stress of less than 20 psi (138 kPa).

O. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed storefront system without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
   1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
   2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.2 MANUFACTURERS

A. Basis of Design: CRL-U.S. Aluminum Defender Series BT601 Blast Resistant Thermal Storefront with Storm Front Entrance Doors by United States Aluminum.

B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

2.3 FRAMING

A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   1. Construction: Thermally broken.
   2. Glazing System: As required for blast resistance.
   3. Glazing Plane: Center.
   4. Finish: Clear anodic finish.
   5. Fabrication Method: Field- or prefabricated stick system.

B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum or steel with nonstaining, nonferrous shims for aligning system components.

D. Materials:
   1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
      a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
      b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
      c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
      d. Structural Profiles: ASTM B 308/B 308M.

   2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
      a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
      b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
      c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.4 ENTRANCE DOOR SYSTEMS

A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.
   1. Door Construction: 2- to 2-1/4-inch (50.8- to 57.2-mm) overall thickness, with minimum 0.125-inch- (3.2-mm-) thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.

a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.

2. Door Design: Medium stile; 3-1/2-inch (88.9-mm) nominal width.
3. Glazing Stops and Gaskets: Manufacturer's standard.
   a. Provide nonremovable glazing stops on outside of door.

2.5 ENTRANCE DOOR HARDWARE

A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 08 71 00 "Door Hardware."

B. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule for each entrance door to comply with requirements in this Section.
   1. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products.
   2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
   3. Opening-Force Requirements:
      a. Egress Doors: Not more than 15 lbf (67 N) to release the latch, not more than 30 lbf (133 N) to set the door in motion and not more than 15 lbf (67 N) to open the door to its minimum required width.
      b. Accessible Interior Doors: Not more than 5 lbf (22.2 N) to open door fully.

C. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of entrance door hardware are indicated in "Entrance Door Hardware Sets" Article at the end of this section. Products are identified by using entrance door hardware designations as follows:
   1. Named Manufacturers' Products: Manufacturer and product designation listed for each door hardware type required are for the purpose of establishing minimum requirements. Manufacturers' names may be abbreviated in "Entrance Door Hardware Sets" Article.
   2. References to BHMA Standards: Where listed, provide products complying with these standards and requirements for description, quality, and function.

D. Pivot Hinges: BHMA A156.4, Grade 1.
   1. Offset-Pivot Hinges: Provide top, bottom, and intermediate offset pivots at each door leaf.

E. Mortise Auxiliary Locks: BHMA A156.5, Grade 1.

F. Panic Exit Devices: BHMA A156.3, Grade 1, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

G. Cylinders: As specified in Section 087100 "Door Hardware."

H. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.

I. Operating Trim: BHMA A156.6.

J. Removable Mullions: BHMA A156.3, extruded aluminum.
   1. When used with panic exit devices, provide removable mullions listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305. Use only mullions that have been tested with exit devices to be used.

K. Closers: BHMA A156.4, Grade 1, with accessories required for a complete installation, sized as required by door size, exposure to weather, and anticipated frequency of use; adjustable to comply with field conditions and requirements for opening force.

L. Door Stops: BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.

M. Weather Stripping: Manufacturer's standard replaceable components.
   1. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.
   2. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

N. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.

O. Silencers: BHMA A156.16, Grade 1.

P. Thresholds: BHMA A156.21, raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch (12.7 mm).

Q. Finger Guards: Manufacturer's standard collapsible neoprene or PVC gasket anchored to frame hinge-jamb at center-pivoted doors.

2.6 GLAZING

A. Glazing: Comply with Section 08 80 00 "Glazing."

B. Glazing Gaskets: Comply with Division 8 Section "Glazing" and Division 8 Section, “Aluminum Window Blast Requirements.”

C. Glazing Sealants: Comply with Section 08 80 00 "Glazing" and Division 8 Section, “Aluminum Window Blast Requirements.”

D. Sealants used inside the weatherproofing system shall have a maximum VOC content of 250 g/L.

E. Sealants used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Structural Glazing Sealants: ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in storefront system indicated.
   1. Color: Black.

G. Weatherseal Sealants: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed storefront manufacturers for this use.
   1. Color: Match structural sealant.

2.7 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   2. Reinforce members as required to receive fastener threads.
   3. Use exposed fasteners with countersunk Phillips screw heads.

B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
   1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

D. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

2.8 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Physical and thermal isolation of glazing from framing members.
   4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   5. Provisions for field replacement of glazing from exterior.

6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.

F. Storefront Framing: Fabricate components for assembly using manufacturer's standard system.

G. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
1. At exterior doors, provide compression weather stripping at fixed stops.
2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.

H. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
2. At exterior doors, provide weather sweeps applied to door bottoms.

I. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

J. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.9 ALUMINUM FINISHES

A. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 percent PVDF or FEVE resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
1. Color and Gloss: Clear Anodized.

2.10 SOURCE QUALITY CONTROL

A. Structural Sealant: Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

A. General:
   1. Comply with manufacturer's written instructions.
   2. Do not install damaged components.
   3. Fit joints to produce hairline joints free of burrs and distortion.
   4. Rigidly secure nonmovement joints.
   5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
   6. Seal perimeter and other joints watertight unless otherwise indicated.

B. Metal Protection:
   1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
   2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Set continuous sill members and flashing in full sealant bed as specified in Section 079200 "Joint Sealants" to produce weathertight installation.

D. Install components plumb and true in alignment with established lines and grades.

E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

F. Install glazing as specified in Section 088000 "Glazing."

G. Install weatherseal sealant according to Section 079200 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

H. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
   1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.

2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.4 ERECTION TOLERANCES

A. Erection Tolerances: Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:
   1. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
   2. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
   3. Alignment:
      a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
      b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
      c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).
   4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.6 m); 1/2 inch (12.7 mm) over total length.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Structural-Sealant Adhesion: Test structural sealant according to recommendations in ASTM C 1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.
   1. Test a minimum of one area on each building facade.
   2. Repair installation areas damaged by testing.

C. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 MAINTENANCE SERVICE

A. Entrance Door Hardware:
   1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.
   2. Initial Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of entrance door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper entrance door hardware operation at rated speed and capacity. Use parts and supplies that are the same as those used in the manufacture and installation of original equipment.

3.7 ENTRANCE DOOR HARDWARE SETS

A. See hardware schedule in Section 08 71 00.

END OF SECTION

SECTION 08 71 00
DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Mechanical door hardware for the following:
      a. Swinging doors.
   2. Cylinders for door hardware specified in other Sections.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

B. Keying Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product in each finish specified.

C. Door hardware schedule.

D. Keying schedule.

1.4 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and Owner about door hardware and keying.
   1. Scheduling Responsibility: Preparation of door hardware and keying schedule.

B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as an Architectural Hardware Consultant (AHC).

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:
      a. Exit Devices: Two years from date of Substantial Completion.
      b. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

B. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that complies with requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
   1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at the tested pressure differential of 0.3-inch wg (75 Pa) of water.

C. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

D. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the DOJ's "2010 ADA Standards for Accessible Design" ICC A117.1.

2.2 HINGES

A. Hinges: BHMA A156.1.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allegion plc.
      b. Baldwin Hardware Corporation.
      c. Bommer Industries, Inc.
      d. Hager Companies.
      e. McKinney Products Company; an ASSA ABLOY Group company.

2.3 CONTINUOUS HINGES

A. Continuous Hinges: BHMA A156.26; minimum 0.120-inch- (3.0-mm-) thick, hinge leaves with minimum overall width of 4 inches (102 mm); fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.

2.4 MECHANICAL LOCKS AND LATCHES

A. Basis of Design system is Falcon K Series Grade 1 Cylindrical Lever Locks. Other manufacturers meeting or exceeding performance requirements will be acceptable.

B. Lock Functions: As indicated in door hardware schedule.

C. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
   1. Bored Locks: Minimum 1/2-inch (13-mm) latchbolt throw.
   2. Mortise Locks: Minimum 3/4-inch (19-mm) latchbolt throw.
   3. Deadbolts: Minimum 1-inch (25-mm) bolt throw.

D. Lock Backset: 2-3/4 inches (70 mm) unless otherwise indicated.

E. Lock Trim:
   1. Description: Manufacturer's standard for function and duty.
   2. Levers: Wrought or Forged.
      a. Provide non-handed design, Falcon "Dane" or similar.
   3. Escutcheons (Roses): Wrought or Forged.
   4. Dummy Trim: Match lever lock trim and escutcheons.

F. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
   1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
   2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
   3. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
   4. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.

G. Bored Locks: BHMA A156.2; Grade 1; Series 4000.

2.5 AUXILIARY LOCKS

A. Bored Auxiliary Locks: BHMA A156.36: Grade 1; with strike that suits frame.

B. Mortise Auxiliary Locks: BHMA A156.36; Grade 1; with strike that suits frame.

C. Narrow Stile Auxiliary Locks: BHMA A156.36; Grade 1; with strike that suits frame.

2.6 EXIT LOCKS AND EXIT ALARMS

A. Exit Locks and Alarms: BHMA A156.29, Grade 1.
   1. Basis of Design product is Falcon 24/25 Series, Device EA-24-R, or equal.

2.7 SURFACE BOLTS

A. Surface Bolts: BHMA A156.16.

2.8 MANUAL FLUSH BOLTS

A. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch (19-mm) throw; designed for mortising into door edge.

2.9 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices and Auxiliary Items: BHMA A156.3.
1. Basis of Design product is Falcon 24/25 Series panic exit hardware with standard keyed dogging, or equal.

2.10 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver. Provide cylinder from same manufacturer of locking devices.

B. Standard Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match lockset.
1. Core Type: Interchangeable.

C. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.11 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock. Incorporate decisions made in keying conference.
1. Master Key System: Change keys and a master key operate cylinders.
a. Provide three cylinder change keys and five master keys.

B. Keys: Nickel silver.
1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
a. Notation: Information to be furnished by Owner.

2.12 KEY CONTROL SYSTEM

A. Key Control Cabinet: BHMA A156.28; metal cabinet with baked-enamel finish; containing key-holding hooks, labels, two sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers; with key capacity of 150 percent of the number of locks.
1. Wall-Mounted Cabinet: Grade 1 cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock.

2.13 OPERATING TRIM

A. Operating Trim: BHMA A156.6; stainless steel unless otherwise indicated.

2.14 ACCESSORIES FOR PAIRS OF DOORS

A. Astragals: BHMA A156.22.

2.15 SURFACE CLOSERS

A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
   1. Basis of Design is Falcon SC70A Series Closer, or equal.

2.16 MECHANICAL STOPS AND HOLDERS

A. Wall- and Floor-Mounted Stops: BHMA A156.16.

2.17 OVERHEAD STOPS AND HOLDERS

A. Overhead Stops and Holders: BHMA A156.8.

2.18 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

B. Maximum Air Leakage: When tested according to ASTM E283 with tested pressure differential of 0.3-inch wg (75 Pa), as follows:
   1. Smoke-Rated Gasketing: 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) of door opening.
   2. Gasketing on Single Doors: 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) of door opening.
   3. Gasketing on Double Doors: 0.50 cfm per foot (0.000774 cu. m/s per m) of door opening.

2.19 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

2.20 METAL PROTECTIVE TRIM UNITS

A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch- (1.3-mm-) thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.

2.21 AUXILIARY DOOR HARDWARE

A. Auxiliary Hardware: BHMA A156.16.

2.22 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.
   1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
   2. Custom Steel Doors and Frames: HMMA 831.
   3. Wood Doors: DHI's "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.

C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule, but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every 30 inches (750 mm) of door height greater than 90 inches (2286 mm).

E. Lock Cylinders: Install construction cores to secure building and areas during construction period.
   1. Furnish permanent cores to Owner for installation.

F. Key Control Cabinet: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

G. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."

H. Stops: Provide wall stops for doors unless floor or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

I. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
   1. Do not notch perimeter gasketing to install other surface-applied hardware.

J. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

K. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.2 ADJUSTING

A. Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.3 DOOR HARDWARE SCHEDULE

A. As provided on Drawings.

END OF SECTION

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SECTION 08 80 00
GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:
1. Glass for windows, doors, interior borrowed lites, and storefront framing.
2. Glazing sealants and accessories.

1.3 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. IBC: International Building Code.

D. Interspace: Space between lites of an insulating-glass unit.

1.4 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches (300 mm) square.
1. Coated glass.
2. Laminated glass.
3. Insulating glass.

C. Glazing Accessory Samples: For sealants and spacers, in 12-inch (300-mm) lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.

D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

E. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturers of insulating-glass units with sputter-coated, low-E coatings, glass testing agency, and sealant testing agency.

B. Product Certificates: For glass.

C. Product Test Reports: For coated glass insulating glass and glazing sealants, for tests performed by a qualified testing agency.
   1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

D. Preconstruction adhesion and compatibility test report.

E. Sample Warranties: For special warranties.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.

B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F (4.4 deg C).

1.10 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
   1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
   1. Warranty Period: 10 years from date of Substantial Completion.

C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design for Insulating Glass Units: Solarban 70XL, as manufactured by PPG.

B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.

C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 45 00 "Quality Control," to design glazing.

C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
   1. Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.
      a. Wind Design Data: As indicated on Drawings.
   2. Design Snow Loads: As indicated on Drawings.
   3. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.
   4. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

D. Windborne-Debris-Impact Resistance: Exterior glazing shall comply with protection testing requirements in ASTM E 1996 as specified in Division I Section Aluminum Window Blast Requirements.

E. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

F. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
   1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
   2. For laminated-glass lites, properties are based on products of construction indicated.
   3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
   4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
   5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
   6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
   1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
   2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
   3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
   4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
   1. Minimum Glass Thickness for Exterior Lites: 6 mm.
   2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.

B. Ultraclear Float Glass: ASTM C 1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent.

C. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
   1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

D. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
   1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

2.5 LAMINATED GLASS

A. Laminated Glass: ASTM C 1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
   1. Construction: Laminate glass with to comply with interlayer manufacturer's written instructions.
   2. Interlayer Thickness: Provide thickness as needed to comply with requirements.
   3. Interlayer Color: Clear unless otherwise indicated.

B. Windborne-Debris-Impact-Resistant Laminated Glass: Comply with requirements specified for laminated glass:

2.6 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
   1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
   2. Spacer: Manufacturer's standard spacer material and construction.
   3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.7 GLAZING SEALANTS

A. General:
   1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
   2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
   3. Field-applied sealants shall have a VOC content of not more than 250 g/L.
   4. Sealants shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
   5. Colors of Exposed Glazing Sealants: As indicated by manufacturer's designations.

B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
   1. Applications: Where required for blast resistance.

2.8 GLAZING TAPES

A. Based on manufacturer’s requirements, provide one of the following:
   1. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800:
   2. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
      a. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
      b. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.9 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.10 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
   1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
      a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C).

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
   1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
   2. Presence and functioning of weep systems.
   3. Minimum required face and edge clearances.
   4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
   1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
   2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.6 CLEANING AND PROTECTION

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
   1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.7 MONOLITHIC GLASS SCHEDULE

A. Glass Type GL-1: Clear annealed, heat-strengthened, or fully tempered float glass as indicated.
   1. Minimum Thickness: 6 mm.
   2. Safety glazing where required.

B. Glass Type GL-2: Ultraclear annealed, heat-strengthened, or fully tempered float glass.
   1. Basis-of-Design Product: PPG Industries, Inc.; Starphire.
   2. Minimum Thickness: 6 mm.
   3. Safety glazing where required

3.8 INSULATING GLASS SCHEDULE

A. Glass Type GL-3: Low-E Coated ultraclear insulating glass.
   1. Basis-of-Design Product: Solarban 70 XL, as manufactured by PPG.
   2. Overall Unit Thickness: 1 inch (25 mm) + thickness required for laminated glass.
   3. Minimum Thickness of Each Glass Lite: 6 mm, except where laminated glass specifications make other requirements.
   4. Outdoor Lite: Ultraclear annealed, heat-strengthened, or fully tempered float glass, as required.
   5. Low-E coating on manufacturer's standard surface.
   6. Interspace Content: Air.
   7. Indoor Lite: Annealed, heat-strengthened, or fully tempered float glass.
   8. Winter Nighttime U-Factor: .29 maximum.
   9. Summer Daytime U-Factor: .26 maximum.
   10. Visible Light Transmittance: 62% minimum.
   11. Solar Heat Gain Coefficient: .29 maximum.
   12. Safety glazing as required.

3.9 INSULATING-LAMINATED-GLASS SCHEDULE

A. Glass Type GL-4: Low-E-coated, clear insulating laminated glass.
   1. Product: Provide Low-E-coated clear insulating laminated glass to meet specified insulating glass standards.
   2. Overall Unit Thickness: As required for performance specified.

3. Minimum Thickness of Outdoor Lite: As required for performance specified.
4. Outdoor Lite: Annealed, Heat-strengthened, or Fully tempered float glass as indicated.
5. Interspace Content: Air.
6. Indoor Lite: Clear laminated glass with two plies of annealed, heat-strengthened, or fully tempered float glass, as required to meet specified standards.
    a. Minimum Thickness of Each Glass Ply: As required for performance specified.
    b. Interlayer Thickness: As required for performance specified.
7. Low-E Coating: Pyrolytic or sputtered on second or third surface.
8. Winter Nighttime U-Factor: Performance based on GL-3 Insulating Glass, as modified to account for laminated indoor lite.
9. Summer Daytime U-Factor: Performance based on GL-3 Insulating Glass, as modified to account for laminated indoor lite.
10. Visible Light Transmittance: Performance based on GL-3 Insulating Glass, as modified to account for laminated indoor lite.
11. Solar Heat Gain Coefficient: Performance based on GL-3 Insulating Glass, as modified to account for laminated indoor lite.
12. Safety glazing as required.

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SECTION 08 88 13
FIRE-RATED GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Fire-resistance-rated glazing.

1.2 DEFINITIONS

A. Fire-Resistance-Rated Glazing: Glazing that prevents spread of fire and smoke and radiant heat; used in rated wall and door applications 60 minutes and above without size limitations.

B. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

C. Glass Thicknesses: Indicated by thickness designations in millimeters in accordance with ASTM C1036.

1.3 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: For each type of glass product; 12 inches (300 mm) square.

C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of glass and glazing product.

C. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the NGA's Certified Glass Installer Program.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials in accordance with manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install fire-resistant glazing until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature conditions at occupancy levels during remainder of construction period.

1.9 WARRANTY

A. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Glass: For each glass type, obtain from single source from single manufacturer.
   1. Basis-of-Design Product: Pilkington Pyrostop® as manufactured by the Pilkington Group and distributed by Technical Glass Products, 8107 Bracken Place SE, Snoqualmie, WA 98065, voice (800.426.0279) fax (425.396.8300), e-mail sales@fireglass.com, Web site www.fireglass.com.

B. Source Limitations for Glazing Accessories: For each product and installation method, obtain from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and impact loads (where applicable) without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; deterioration of glazing materials; or other defects in construction.

2.3 GLASS PRODUCTS, GENERAL

A. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities

having jurisdiction. Label shall indicate manufacturer's name, type of glass, glass thickness, and safety glazing standard with which glass complies.

2.4 GLASS PRODUCTS

A. Low-Iron Float Glass: ASTM C1036, Type I, Quality-Q3, Class I (clear), with visible light transmission not less than 91 percent.

2.5 FIRE-RESISTANCE-RATED GLAZING

A. Fire-Resistance-Rated Glazing: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-resistance ratings indicated, based on testing in accordance with ASTM E119 or UL 263.

B. Fire-Resistance-Rated Glazing Labeling: Permanently mark fire-resistance-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, that glazing is approved for use in walls, and fire-resistance rating in minutes.

C. Fire-Resistance-Rated Framing and Doors: Fire-resistance-rated glazing with 60-, 90-, and 120-minute ratings requires framing and doors from glass supplier, tested as an assembly complying with ASTM E119 or UL 263.

D. Fire-Resistance-Rated Laminated Glass with Intumescent Interlayers: Laminated glass made from multiple plies of uncoated, low-iron float glass; with intumescent interlayers; complying with 16 CFR 1201, Category II.

E. Frames: By or as required by Fire-Resistant Glazing manufacturer to achieve required assembly fire rating(s).

2.6 GLAZING ACCESSORIES

A. Provide glazing gaskets, glazing sealants, glazing tapes, setting blocks, spacers, edge blocks, and other glazing accessories that are compatible with glazing products and each other and are approved by testing agencies that listed and labeled fire-resistant glazing products with which products are used for applications and fire-protection ratings indicated.

B. Silicone Sealant: One-part neutral curing silicone, medium modulus sealant, Type S; Grade NS; Class 25 with additional movement capability of 50 percent in both extension and compression (total 100 percent); Use (Exposure) NT; Uses (Substrates) G, A, and O as applicable. Available Products:
   1. Dow Corning 795 - Dow Corning Corp.
   2. Silglaze-II 2800 - General Electric Co.
   3. Spectrem 2 - Tremco Inc.
   4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range of industry colors.

C. Setting Blocks: Hardwood or calcium silicate; glass width by 4 inches by 3/16 inch thick.

D. Spacers: Neoprene or other resilient blocks of 40 to 50 Shore A durometer hardness, adhesive-backed on one face only, tested for compatibility with specified glazing compound.

E. Cleaners, Primers, and Sealers: Type recommended by manufacturer of glass and gaskets.

2.7 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Perimeter Insulation for Fire-Resistance-Rated Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.8 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine glass framing, with glazier present, for compliance with the following:
   1. Manufacturing and installation tolerances, including those for size, squareness, offsets at corners.
   2. Minimum required face or edge clearances.
   3. Observable edge damage or face imperfections.

B. Do not proceed with glazing until unsatisfactory conditions have been corrected.

C. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings that are not firmly bonded to substrates.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate fire side and protected side. Label or mark units as needed so that fire side and protected side are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

A. METHODS IN THIS SECTION ARE FOR GENERAL REFERENCE ONLY. USE ONLY THOSE INSTALLATION METHODS AND MATERIALS RECOMMENDED OR REQUIRED BY THE GLAZING MANUFACTURER TO OBTAIN THE REQUIRED ASSEMBLY FIRE RATING.

B. Use methods approved by testing agencies that listed and labeled fire-resistant glazing products.

C. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publications.

D. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

E. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

F. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

G. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

H. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
   1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
   2. Provide 1/8-inch- (3-mm-) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

I. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.

J. Set glass lites with proper orientation so that coatings face fire side or protected side as specified.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop, so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

D. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

A. Immediately after installation, remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
   1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.8 FIRE-RESISTANCE-RATED GLAZING SCHEDULE

A. Glass Type: 120-minute fire-resistance-rated glazing complying with ASTM E119 or UL 263 in a tested assembly of glass and framing with 450 deg F (250 deg C) temperature-rise limitation; fire-resistance-rated laminated glass with intumescent interlayers.

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DIVISION 09
FINISHES

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SECTION 09 11 16
NON-LOAD-BEARING STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes non-load-bearing steel framing members for the following applications:
   1. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).
   2. Interior suspension systems (e.g., supports for ceilings, suspended soffits, etc.).

B. Related Sections include the following:
   1. Division 5 Section "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; roof rafters and ceiling joists; and roof trusses.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE

A. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

PART 2 - PRODUCTS

2.1 NON-STRUCTURAL METAL FRAMING, GENERAL

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
   1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
   2. Protective Coating: ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized, unless otherwise indicated.

2.2 SUSPENSION SYSTEM COMPONENTS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.

B. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch (4.12-mm) diameter.

C. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch (1.37 mm) and minimum 1/2-inch- (12.7-mm-) wide flanges.
1. Depth: 2-1/2 inches (64 mm).

D. Furring Channels (Furring Members):
1. Cold-Rolled Channels: 0.0538-inch (1.37-mm) bare-steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flanges, 3/4 inch (19.1 mm) deep.
2. Steel Studs: ASTM C 645.
   a. Minimum Base-Metal Thickness: 0.0312 inch (0.79 mm).
   b. Depth: As indicated on Drawings.
3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22.2 mm) deep.
   a. Minimum Base Metal Thickness: 0.0312 inch (0.79 mm).

E. Grid Suspension System for Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:
   a. Armstrong World Industries, Inc.; Drywall Grid Systems.
   b. Chicago Metallic Corporation; 640-C Drywall Furring System.
   c. USG Corporation; Drywall Suspension System.

2.3 STEEL FRAMING FOR FRAMED ASSEMBLIES

A. Steel Studs and Runners: ASTM C 645.
1. Minimum Base-Metal Thickness: 0.0312 inch (0.79 mm).
2. Depth: As indicated on Drawings.

B. Slip-Type Head Joints: Where indicated, provide one of the following:
1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- (50.8-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- (50.8-mm-) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

a. Products: Subject to compliance with requirements, provide one of the following:
   1) Steel Network Inc. (The); VertiClip SLD Series.
   2) Superior Metal Trim; Superior Flex Track System (SFT).

C. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
   1. Minimum Base-Metal Thickness: 0.027 inch (0.7 mm).

D. Cold-Rolled Channel Bridging: 0.0538-inch (1.37-mm) bare-steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flanges.
   1. Depth: 1-1/2 inches (38.1 mm).
   2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38.1 by 38.1 mm), 0.068-inch- (1.73-mm-) thick, galvanized steel.

E. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
   1. Minimum Base Metal Thickness: 0.0312 inch (0.79 mm).
   2. Depth: 7/8 inch (22.2 mm).

F. Resilient Furring Channels: 1/2-inch- (12.7-mm-) deep, steel sheet members designed to reduce sound transmission.
   1. Configuration: Asymmetrical or hat shaped.

G. Cold-Rolled Furring Channels: 0.0538-inch (1.37-mm) bare-steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flanges.
   1. Depth: 3/4 inch (19.1 mm).
   2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare-steel thickness of 0.0312 inch (0.79 mm).
   3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.

H. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (31.8 mm), wall attachment flange of 7/8 inch (22.2 mm), minimum bare-metal thickness of 0.0179 inch (0.45 mm), and depth required to fit insulation thickness indicated.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.
   1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
   1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.
   1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
   a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

3.5 INSTALLING FRAMED ASSEMBLIES

A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

B. Install studs so flanges within framing system point in same direction.
1. Space studs as follows:
   a. Single-Layer Application: 16 inches (406 mm) o.c., unless otherwise indicated.
   b. Multilayer Application: 16 inches (406 mm) o.c., unless otherwise indicated.
   c. Tile backing panels: 16 inches (406 mm) o.c., unless otherwise indicated.

C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
   a. Install two studs at each jamb, unless otherwise indicated.
   b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (12.7-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.

c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

4. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

D. Direct Furring:

1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.

E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

END OF SECTION

SECTION 09 29 00
GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
1. Interior gypsum board.
2. Exterior gypsum board for ceilings and soffits.

B. Related Sections include the following:
1. Division 5 Section "Structural Steel Framing" for structural steel framing that supports gypsum board.
2. Division 7 Section "Thermal Insulation" for insulation installed in assemblies that incorporate gypsum board.
3. Division 9 Section "Non-Load-Bearing Metal Framing" for non-structural framing and suspension systems that support gypsum board.
4. Division 9 painting Sections for primers applied to gypsum board surfaces.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For the following products:
1. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim accessory indicated.

1.4 QUALITY ASSURANCE

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

1.5 STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install interior products until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PANELS, GENERAL

A. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.2 INTERIOR GYPSUM BOARD

A. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.
   1. Manufacturers: Subject to compliance with requirements, manufacturers whose products may be included in the work include but are not limited to the following:
      a. American Gypsum Co.
      b. BPB America Inc.
      c. G-P Gypsum.
      d. Lafarge North America Inc.
      e. National Gypsum Company.
      f. PABCO Gypsum.
      g. Temple.
      h. USG Corporation.

B. Type X:
   1. Thickness: 5/8 inch (15.9 mm).
   2. Long Edges: Tapered.

C. Ceiling Type: Manufactured to have more sag resistance than regular-type gypsum board.
   1. Thickness: 5/8 inch (12.7 mm).
   2. Long Edges: Tapered.

D. Impact-Resistant Gypsum Board: ASTM C 1396/C 1396M gypsum board, tested according to ASTM C 1629/C 1629M.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. American Gypsum.
b. CertainTeed Corporation.
c. Georgia-Pacific Gypsum LLC.
d. National Gypsum Company.
e. USG Corporation.

2. Core: 5/8 inch (15.9 mm), Type X.
3. Surface Abrasion: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements.
4. Indentation: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements.
5. Soft-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements.
6. Hard-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements according to test in Annex A1.
7. Long Edges: Tapered.
8. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.3 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.
1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, or paper-faced galvanized steel sheet.
2. Shapes:
a. Cornerbead.
b. LC-Bead: J-shaped; exposed long flange receives joint compound.
c. Expansion (control) joint.
3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.4 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:
1. Interior Gypsum Wallboard: Paper.
2. Tile Backer Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
1. Prefilling, Embedding, and First Coat: At joints, fastener heads, trim flanges, and damaged surface areas, use drying- or setting-type taping compound.
2. Fill Coats and Finish Coat: Use drying or setting-type, sandable topping compound.

2.5 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
   1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.

D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
   1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

E. Acoustical Sealant: As specified in Division 7 Section "Joint Sealants."

F. Thermal Insulation: As specified in Division 7 Section "Building Insulation."

G. Vapor Retarder: As specified in Division 7 Section "Building Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Where required for sound isolation, cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
   1. Fit gypsum panels around ducts, pipes, and conduits.
   2. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:
   1. Type X: As indicated on Drawings.

B. Single-Layer Application:
   1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
   2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
      a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
      b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
   3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:
   1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
   2. On partitions/walls, apply gypsum board indicated for base layers and face layers horizontally with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless

otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.

3. Fastening Methods: Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners.

3.4 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:
1. Cornerbead: Use at outside corners.
2. LC-Bead: Use at exposed panel edges.

D. Aluminum Trim: Install in locations indicated on Drawings.

3.5 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile, panels that are substrate for acoustical tile and where indicated.
3. Level 3: Where indicated on Drawings.
4. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.
   a. Primer and its application to surfaces are specified in other Division 9 Sections.
5. Level 5: Where indicated on Drawings.

3.6 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

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SECTION 09 30 13
CERAMIC TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Porcelain tile.
2. Glazed wall tile.
3. Stone thresholds.
4. Waterproof membrane.
5. Crack isolation membrane.
6. Metal edge strips.

B. Related Requirements:
1. Division 7 Section "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

1.3 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. Module Size: Actual tile size plus joint width indicated.

C. Face Size: Actual tile size, excluding spacer lugs.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

C. Samples for Initial Selection: For tile, grout, and accessories involving color selection.

D. Samples for Verification:
1. Full-size units of each type and composition of tile and for each color and finish required.
2. Full-size units of each type of trim and accessory.
3. Stone thresholds in 6-inch (150-mm) lengths.
4. Metal edge strips in 6-inch (150-mm) lengths.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

C. Product Certificates: For each type of product.

D. Product Test Reports: For tile-setting and -grouting products [and certified porcelain tile].

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
   2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer employs Ceramic Tile Education Foundation Certified Installers.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockup of each type of floor tile installation.
   2. Build mockup of each type of wall tile installation.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
   1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
   1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
   2. Obtain waterproof membrane and crack isolation membrane, except for sheet products, from manufacturer of setting and grouting materials.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
   1. Stone thresholds.
   2. Metal edge strips.

2.2 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
   1. Provide tile complying with Standard grade requirements unless otherwise indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

2.3 TILE PRODUCTS

A. Ceramic Tile Type T-1: Glazed pressed floor and wall tile.

1. Composition: Vitreous or impervious natural clay or porcelain.
2. Face Size: 3 by 3 inches (floor), 3 by 6 inches (wall),
3. Face Size Variation: Calibrated or rectified.
4. Thickness: 1/4 inch (6.4 mm).
5. Face: Pattern of design indicated (floor), Smooth (wall), with square or cushion edges.
6. Dynamic Coefficient of Friction: Not less than 0.42.
7. Glaze: Mat, clear.
8. Tile Color and Pattern: Match Architect's sample.
9. Grout Color: Match Architect's sample.
10. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
    a. Base Cove: Cove, module size same as adjoining flat tile.
    b. External Corners for Thinset Mortar Installations: Surface bullnose, module size same as adjoining flat tile.
    c. Internal Corners: Field-butted square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.

B. Ceramic Tile Type T-2: Glazed wall tile.
1. Module Size: 6 by 3 inches, except as shown otherwise on drawings.
2. Face Size Variation: Rectified.
3. Thickness: 1/4 inch.
4. Face: Plain with cushion edges.
5. Finish: Bright, opaque glaze.
6. Tile Color and Pattern: Match Architect's sample.
7. Grout Color: As selected by Architect from manufacturer's full range.
8. Mounting: Back mounted.
9. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
    a. External Corners for Thinset Mortar Installations: Surface bullnose, same size as adjoining flat tile.
    b. Internal Corners: Field-butted square corners. For coved base and cap use angle pieces designed to fit with stretcher shapes.

2.4 THRESHOLDS

A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch (1.5 mm) above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch (12.7 mm) or less above adjacent floor surface.

B. Granite Thresholds: ASTM C 615/C 615M, with honed finish.
1. Description: Uniform, medium-grained, warm gray stone without veining.

2.5 WATERPROOF MEMBRANE

A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer. Provide one of the following:

B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric.
1. Nominal Thickness: 0.030 inch (0.76 mm).

C. PVC Sheet: PVC heat-fused on both sides to facings of nonwoven polyester.
1. Nominal Thickness: 0.025 inch (0.6 mm).

D. Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; 0.008-inch (0.2-mm) nominal thickness.

E. Fabric-Reinforced, Modified-Bituminous Sheet: Self-adhering, SBS-modified-bituminous sheet with fabric reinforcement facing; 0.040-inch (1 -mm) nominal thickness.

F. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.

G. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.

2.6 CRACK ISOLATION MEMBRANE

A. General: Manufacturer's standard product that complies with ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer. Provide one of the following. If crack isolation membrane meets waterproofing requirements, use crack isolation only; do not use both.

B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch (0.76-mm) nominal thickness.

C. PVC Sheet: PVC heat-fused on both sides to facings of nonwoven polyester; 0.040-inch (1-mm) nominal thickness.

D. Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; 0.008-inch (0.2-mm) nominal thickness.

E. Corrugated Polyethylene: Corrugated polyethylene with dovetail-shaped corrugations and with anchoring webbing on the underside; 3/16-inch (4-mm) nominal thickness.

F. Fabric-Reinforced, Modified-Bituminous Sheet: Self-adhering, modified-bituminous sheet with fabric reinforcement facing; 0.040-inch (1-mm) nominal thickness.

G. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and fabric reinforcement.

H. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.

2.7 SETTING MATERIALS

A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
1. Cleavage Membrane: Asphalt felt, ASTM D 226/D 226M, Type I (No. 15); or polyethylene sheeting, ASTM D 4397, 4.0 mils (0.1 mm) thick.
2. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, 2 by 2 inches (50.8 by 50.8 mm) by 0.062-inch (1.57-mm) diameter; comply with ASTM A 185/A 185M and ASTM A 82/A 82M, except for minimum wire size.
3. Expanded Metal Lath: Diamond-mesh lath complying with ASTM C 847.
   a. Base Metal and Finish for Interior Applications: Uncoated or zinc-coated (galvanized) steel sheet, with uncoated steel sheet painted after fabrication into lath.
   b. Base Metal and Finish for Exterior Applications: Zinc-coated (galvanized) steel sheet.
   c. Configuration over Studs and Furring: Flat.
   d. Configuration over Solid Surfaces: Self-furring.
   e. Weight: 2.5 lb/sq. yd. (1.4 kg/sq. m).
4. Latex Additive: Manufacturer's standard acrylic resin or styrene-butadiene-rubber water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.

B. Latex-Portland Cement Mortar (Thinset): ANSI A118.4.
1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
2. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

2.8 GROUT MATERIALS

A. High-Performance Tile Grout: ANSI A118.7.
1. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.

B. Grout for Pregrouted Tile Sheets: Same product used in factory to pregrout tile sheets.

2.9 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Vapor-Retarder Membrane: Polyethylene sheeting, ASTM D 4397, 4.0 mils (0.1 mm) thick.

C. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; stainless-steel, ASTM A 666, 300 Series exposed-edge material.
   1. Basis of design Manufacturer: Schluter Systems L. P.

D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

E. Grout Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.
   1. Grout sealers shall comply with requirements of FloorScore certification.
   2. Grout sealers shall also comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Small-Scale Environmental Chambers."

2.10 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
   2. Verify that concrete substrates for tile floors installed with adhesives, bonded mortar bed, or thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
      a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
      b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.

3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with adhesives or thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot (1:50) toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 CERAMIC TILE INSTALLATION

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
    a. Tile floors in wet areas.
    b. Tile floors in laundries.
    c. Tile floors consisting of rib-backed tiles.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.

F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
   1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
   2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
   3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
   1. Quarry Tile: 1/4 inch (6.4 mm).
   2. Pressed Floor and Wall Tile: 1/4 inch (6.4 mm).
   3. Glazed Wall Tile: 1/8 inch (3.2 mm) or as needed to ensure floor/wall joint alignment.

H. Lay out tile wainscots to next full tile beyond dimensions indicated. Coordinate wainscots with bathroom mirror installation.

I. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
   1. Set thresholds in latex-portland cement mortar (thinset).
   2. Do not extend cleavage membrane or crack isolation membrane under thresholds. Fill joints between such thresholds and adjoining tile set on crack isolation membrane with elastomeric sealant.

J. Metal Edge Strips: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated.

K. Grout Sealer: Apply grout sealer to cementitious grout joints in tile floors according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 CRACK ISOLATION MEMBRANE INSTALLATION

A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

3.5 ADJUSTING AND CLEANING

A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove grout residue from tile as soon as possible.
2. Clean grout smears, and haze from tile according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.6 PROTECTION

A. Protect installed tile work with Kraft-paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.7 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

1. Ceramic Tile Installation CT-1: TCNA F112 and ANSI A108.1C; cement mortar bed (thickset) bonded to concrete.
    a. Ceramic Tile Type: T-1
    b. Bond Coat for Cured-Bed Method: Medium-bed, latex-portland cement mortar.
    c. Grout: High-performance sanded grout.

B. Interior Wall Installations, Wood or Metal Studs or Furring:

1. Ceramic Tile Installation CT-2: TCNA W245 or TCNA W248; thinset mortar on glass-mat, water-resistant gypsum backer board.
    a. Ceramic Tile Type: T-2.
    b. Thinset Mortar: Latex-portland cement mortar.
    c. Grout: High-performance sanded grout.

C. Shower Receptor and Wall Installations:

1. Ceramic Tile Installation CT-3: TCNA B414 and ANSI A108.1C; cement mortar bed (thickset) over vapor-retarder membrane.
    a. Ceramic Tile Type: T-2
    b. Bond Coat: Latex-portland cement mortar.
    c. Grout: High-performance sanded grout.
2. Ceramic Tile Installation CT-4: TCNA B420; thinset mortar on waterproof membrane over coated glass-mat, water-resistant gypsum backer board.
    a. Ceramic Tile Type: T-2.
    b. Thinset Mortar: Latex-portland cement mortar.
    c. Grout: High-performance sanded grout.

END OF SECTION

SECTION 09 51 13
ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes acoustical panels and exposed suspension systems for ceilings.

B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

1.3 DEFINITIONS

A. AC: Articulation Class.

B. CAC: Ceiling Attenuation Class.

C. LR: Light Reflectance coefficient.

D. NRC: Noise Reduction Coefficient.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Ceiling suspension system members.
   2. Method of attaching hangers to building structure.
      a. Furnish layouts for clips, and other ceiling attachment devices whose installation is specified in other Sections.
   3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
   4. Minimum Drawing Scale: 1/8 inch = 1 foot (1:96).

C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
   1. Acoustical Panel: Set of 6-inch- (150-mm-) square Samples of each type, color, pattern, and texture.
   2. Exposed Suspension System Members, Moldings, and Trim: Set of 12-inch- (300-mm-) long Samples of each type, finish, and color.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each acoustical panel ceiling.

E. Maintenance Data: For finishes to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations:
1. Acoustical Ceiling Panel: Obtain each type through one source from a single manufacturer.
2. Suspension System: Obtain each type through one source from a single manufacturer.

B. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:
1. Fire-Resistance Characteristics: Provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
2. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:
a. Smoke-Developed Index: 450 or less.

C. Seismic Standard: Provide acoustical panel ceilings designed and installed to withstand the effects of earthquake motions according to the following:
1. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.
2. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings--Seismic Zones 0-2."
3. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies--Seismic Zones 3 & 4."
4. UBC Standard 25-2, "Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings."
5. ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.8 COORDINATION

A. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Acoustical Ceiling Panels: Full-size panels equal to 2 percent of quantity installed.
   2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.
   3. Hold-Down Clips: Equal to 2 percent of quantity installed.
   4. Impact Clips: Equal to 2 percent of quantity installed.

PART 2 - PRODUCTS

2.1 ACOUSTICAL PANELS, GENERAL

A. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectance, unless otherwise indicated.

B. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
   1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.2 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING

A. Basis of Design:
   1. (General) Certainteed, Performa, Fine Fissured, white

B. Products: Subject to compliance with requirements, provide one of the following. Match existing panels in building:
   1. Armstrong World Industries, Inc;
   2. BPB USA;

3. Chicago Metallic Corporation;
4. Ecophon CertainTeed, Inc;
5. Tectum Inc;
6. USG Interiors, Inc;

C. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:
1. Type and Form: Type III, mineral base with painted finish; Form 2, water felted.
2. Pattern: D (fissured).

D. Color: White as indicated.

E. LR: Not less than 0.75.

F. NRC: Not less than 0.50.

G. CAC: Not less than 30.

H. AC: Not less than 200.

I. Edge/Joint Detail: Square.

J. Thickness: 5/8 inch (15 mm).

K. Modular Size(s): 24 by 24 inches and 24 by 48 inches, as indicated in Drawings.

L. Antimicrobial Treatment: Broad spectrum fungicide and bactericide based.

2.3 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.

B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish to match ceiling panels and type of system indicated.

C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
a. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.

D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.

2. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.135-inch- (3.5-mm-) diameter wire.

E. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

F. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1-mm-) thick, galvanized steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.

G. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

H. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

I. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in-place.

2.4 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILING

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

B. Products: Subject to compliance with requirements, provide one of the following:
1. Armstrong World Industries, Inc.;.
2. BPB USA;.
3. Chicago Metallic Corporation;.
4. Ecophon CertainTeed, Inc.;.

C. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation, with prefinished 15/16-inch- (24-mm-) wide metal caps on flanges.
1. Structural Classification: Heavy-duty system.
2. End Condition of Cross Runners: Override (stepped) type.
3. Face Design: Flat, flush.
4. Cap Material: Steel cold-rolled sheet.
5. Cap Finish: Painted white.

2.5 METAL EDGE MOLDINGS AND TRIM

A. Products: Subject to compliance with requirements, provide one of the following:
1. Armstrong World Industries, Inc.;.
2. BPB USA;.
3. Chicago Metallic Corporation;.
4. Fry Reglet Corporation;.
5. Gordon, Inc.;.
6. USG Interiors, Inc.;.

B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
   1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
   2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

A. General: Install acoustical panel ceilings to comply with ASTM C 636 and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Suspend ceiling hangers from building's structural members and as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
   2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
   4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.

5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
7. Do not attach hangers to steel deck tabs.
8. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
9. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
2. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions, unless otherwise indicated.

G. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

SECTION 09 65 13
RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Resilient base.
2. Resilient molding accessories.

B. Related Sections:

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection: For each type of product indicated.

C. Samples for Verification: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches (300 mm) long, of each resilient product color, texture, and pattern required.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

1.5 PROJECT CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 68 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive resilient products during the following time periods:
1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).

C. Install resilient products after other finishing operations, including painting, have been completed.

1.6 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Furnish not less than 10 linear feet (3 linear m) for every 500 linear feet (150 linear m) or fraction thereof, of each type, color, pattern, and size of resilient product installed.

PART 2 - PRODUCTS

2.1 RESILIENT BASE

A. Resilient Base:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armstrong World Industries, Inc.
      b. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
      c. Johnsonite.
      d. Mondo Rubber International, Inc.
      e. Roppe Corporation, USA.

B. Resilient Base Standard: ASTM F 1861.
   1. Material Requirement: Type TS (rubber, vulcanized thermoset).
   2. Manufacturing Method: Group I (solid, homogeneous).
   3. Style: Cove (base with toe).

C. Minimum Thickness: 0.080 inch (2.0 mm).

D. Height: 4 inches (102 mm).

E. Lengths: Coils in manufacturer's standard length.

F. Outside Corners: Factory preformed. Straight material back scored and bent in the field is not an acceptable equivalent and will be rejected.

G. Inside Corners: Job formed - coped.

H. Finish: As selected by Architect from manufacturer's full range.

I. Colors and Patterns: As selected by Architect from full range of industry colors

2.2 RESILIENT MOLDING ACCESSORY

A. Resilient Molding Accessory:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
      b. Flexco, Inc.
      c. Johnsonite.

d. R.C.A. Rubber Company (The).
e. Roppe Corporation, USA.

B. Description: Including but not limited to one or more of the following - Carpet bar for tackless installations; Carpet edge for glue-down applications; Reducer strip for resilient floor covering; Joiner for tile and carpet; Transition strips.

C. Material: Rubber.

D. Profile and Dimensions: As selected by Architect from manufacturer's full line.

E. Colors and Patterns: As selected by Architect from full range of industry colors.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.
1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
a. Cove Base Adhesives: Not more than 50 g/L.

C. Floor Polish: Provide protective liquid floor polish products as recommended by resilient stair tread manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates for Resilient Accessories: Prepare according to ASTM F 710.
1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.

2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.
4. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
    a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
    b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient products until they are same temperature as the space where they are to be installed.
1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

H. Job-Formed Corners:
1. Inside Corners: Use straight pieces of maximum lengths possible.

3.4 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of carpet and/or resilient floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.

B. Perform the following operations immediately after completing resilient product installation:
   1. Remove adhesive and other blemishes from exposed surfaces.
   2. Sweep and vacuum surfaces thoroughly.
   3. Damp-mop surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, visible adhesive, and surface blemishes from resilient stair treads before applying liquid floor polish.
   1. Apply two coat(s).

E. Cover resilient products until Substantial Completion.

END OF SECTION

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SECTION 09 65 19
RESILIENT FLOOR TILE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Vinyl composition tile (VCT).

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. For Tile setting adhesives and grout, provide data showing it meets South Coast Air Quality Management District (SCAQMD) Rule 1168. VOC Limits correspond to an effective date of July 1, 2005 and rule amendment date of January 7, 2005.

B. Samples for Initial Selection: For each type of product indicated.

C. Samples for Verification: Full-size units of each color and pattern of resilient floor tile required.
   1. Resilient Wall Base and Accessories: Manufacturer's standard-size Samples, but not less than 12 inches (300 mm) long, of each resilient product color and pattern required.

D. Maintenance Data: For resilient products to include in maintenance manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store tiles on flat surfaces.

1.5 PROJECT CONDITIONS

A. Maintain temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive floor tile during the following time periods:
   1. 48 hours before installation.
   2. During installation.
   3. 48 hours after installation.

B. After postinstallation period, maintain temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).

C. Close spaces to traffic during floor covering installation.

D. Close spaces to traffic for 48 hours after floor covering installation.

E. Install resilient products after other finishing operations, including painting, have been completed.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Floor Tile: Furnish 1, unopened box of each type, color, and pattern of floor tile installed. Label box(es) with room numbers where installed.
   2. Resilient Wall Base and Accessories: Furnish not less than 10 linear feet (3 linear m) for every 500 linear feet (150 linear m) or fraction thereof, of each type, color, pattern, and size of resilient product installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 COLORS AND PATTERNS

A. Colors and Patterns: As selected by Architect from manufacturer's full range.

2.3 VINYL COMPOSITION TILE (F-1)

A. Vinyl Composition Tile (VCT): ASTM F 1066.
   1. AB ColorPlus, American Biltrite (Canada) Ltd.;.
   2. Armstrong World Industries, Inc.;.
   3. Azrock Commercial Flooring, DOMCO;.
   4. Congoleum Corporation;.
   5. Mannington Mills, Inc.;.
   6. Tarkett Inc.;.

B. Class: 2 (through-pattern tile).

C. Wearing Surface: Smooth.

D. Thickness: 0.125 inch (3.2 mm).

E. Size: 12 by 12 inches (305 by 305 mm).

F. Fire-Test-Response Characteristics:
1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm per ASTM E 648.

2.4 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic cement based formulation provided or approved by resilient product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.
1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
a. VCT and Asphalt Tile Adhesives: 50 g/L.
b. Cove Base Adhesives: 50 g/L.
c. Rubber Floor Adhesives: 60 g/L.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance.
1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written recommendations to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F 710.
1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
3. Moisture Testing:
a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
b. Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

C. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.

D. Use trowelable leveling and patching compound to fill cracks, holes, and depressions in substrates.

E. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
   1. Do not install resilient products until they are same temperature as space where they are to be installed.

F. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 TILE INSTALLATION

A. Lay out tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
   1. Lay tiles square with room axis.

B. Match tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
   1. Lay tiles with grain direction alternating in adjacent tiles (basket-weave pattern).

C. Scribe, cut, and fit tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, edgings, door frames, thresholds, and nosing's.
   1. At elevator equipment room, coordinate installation of tile to take place prior to installation of elevator equipment.

D. Extend tiles into toe spaces, door reveals, closets, and similar openings.

E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.

F. Install tiles on covers for telephone and electrical ducts and similar items in finished floor areas. Maintain overall continuity of color and pattern with pieces of tile installed on covers. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

G. Adhere tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after completing resilient product installation:
   1. Remove adhesive and other blemishes from exposed surfaces.

2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.
    a. Do not wash surfaces until after time period recommended by manufacturer.

B. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.
1. Apply protective floor polish to horizontal surfaces that are free from soil, visible adhesive and surface blemishes if recommended in writing by manufacturer.
    a. Coordinate selection of floor polish with Owner's maintenance service.
2. Do not move heavy and sharp objects directly over surfaces. Place hardboard or plywood panels over flooring and under objects while they are being moved. Slide or roll objects over panels without moving panels.

END OF SECTION

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SECTION 09 68 16
SHEET CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Tufted carpet.
2. Carpet cushion.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For carpet installation, showing the following:
1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.
2. Carpet type, color, and dye lot.
3. Seam locations, types, and methods.
4. Type of subfloor.
5. Type of installation.
6. Pattern type, repeat size, location, direction, and starting point.
7. Pile direction.
8. Types, colors, and locations of insets and borders.
9. Types, colors, and locations of edge, transition, and other accessory strips.
10. Transition details to other flooring materials.
11. Type of carpet cushion.

C. Samples: For each exposed product and for each color and texture required.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.7 WARRANTY

A. Special Warranty for Carpet: Manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

B. Special Warranty for Carpet Cushion: Manufacturer agrees to repair or replace components of carpet cushion installation that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TUFTED CARPET (C1)

A. Basis-of-Design Carpet is Milliken “Plank” Broadloom. Other carpets by this and other manufacturers may be acceptable, contingent upon their meeting construction and performance requirements listed herein.

B. Color: As selected by Architect from manufacturer's full range.

C. Pattern: As selected by Architect from manufacturer’s full line in the selected range.

D. Fiber Content: 100 percent nylon 6, 6 or 100 percent nylon 6.

E. Pile Characteristic: Tufted, tip shear pile.

F. Yarn Count: 168 per square inch.

G. Density: 6,545 **oz./cu. yd.** .

H. Pile Thickness: **0.187 inches** for finished carpet.

I. Face Weight: **34 oz./sq. yd.**.

J. Total Weight: 67 **oz./sq. yd.** for finished carpet.

K. Primary Backing: Manufacturer's standard material.

L. Secondary Backing: Manufacturer’s standard integral pad material meeting warranty requirements..

M. Backcoating: Manufacturer's standard material.

N. Retain "Backing System" Paragraph below if naming a proprietary backing system, such as "ActionBac" by Propex.Roll Width: Not less than 12 feet.

O. Applied Treatments:
   1. Applied Soil-Resistance Treatment: Manufacturer's standard material.

2. Antimicrobial Treatment: Manufacturer's standard material.
   a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.

P. Performance Characteristics:
1. Appearance Retention Rating: Heavy traffic, 3.0 minimum according to ASTM D7330.
2. Dry Breaking Strength: Not less than 100 lbf (445 N) according to ASTM D2646.
3. Tuft Bind: Not less than 10 lbf (45 N) according to ASTM D1335.
4. Delamination: Not less than 4 lbf/in. (.07 N/mm) according to ASTM D3936.
5. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.
6. Colorfastness to Light: Not less than 4 after 40 AFU (AATCC fading units) according to AATCC 16, Option E.
7. Electrostatic Propensity: Less than 3.5 kV according to AATCC 134.

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended or provided by carpet manufacturer.

C. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Concrete Slabs:
1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (18.6 sq. m), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
   a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) . in 24 hours, and meet carpet and carpet adhesive manufacturer's requirements.
   b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
   c. Perform additional moisture tests recommended in writing by adhesive and carpet manufacturers. Proceed with installation only after substrates pass testing.

3.2 PREPARATION

A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet manufacturer's written installation instructions for preparing substrates.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm), unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet manufacturers.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

3.3 INSTALLATION

A. Comply with the Carpet and Rug Institute's CRI 104 and carpet manufacturer's written installation instructions for the following:
1. Direct-glue-down installation.
2. Carpet with attached-cushion installation.
3. Preapplied adhesive installation.
4. Stair installation.

B. Comply with carpet manufacturer's written instructions and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.

C. Install as indicated in approved shop drawings.

D. Install borders with mitered corner seams.

E. Do not bridge building expansion joints with carpet.

F. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.

G. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

H. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet as marked on subfloor. Use nonpermanent, nonstaining marking device.

I. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods recommended in writing by carpet manufacturer and carpet adhesive manufacturer.

END OF SECTION

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SECTION 09 90 00
PROTECTIVE COATINGS

PART 1 GENERAL

1.1 WORK INCLUDED

A. This section covers surface preparation, furnishing, and application of protective coatings, complete.

B. It is the intent of this specification that all new or existing expose metal surfaces, shall be coated with a protective coating, unless specifically excluded.

C. Shop or existing surface preparation methods, cleanliness, and existing paint, rust, and mill scale removal is not known nor documented. Contractor shall be solely responsible for determining work effort, abrasive blast requirements, and any other factors that may affect work productivity as required to provide the specified surface preparation cleanliness; regardless of prior system preparation or coating application.

1.2 RELATED SECTIONS:

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
1. Section 01 33 20 - Submittal Procedures.
2. Section 05 50 00 – Metal Fabrications
3. Section 09 91 23 – Interior Painting

1.3 GENERAL:

A. See section GENERAL CONDITIONS, which contain information and requirements that apply to the work specified and are mandatory for this project.

1.4 ABBREVIATIONS

ANSI	American National Standards Institute
AWWA	American Water Works Association
MDFT	Minimum Dry Film Thickness

MDFTPC	Minimum Dry Film Thickness Per Coat
mil	Thousandths of an Inch
OSHA	Occupational Safety and Health Act
PSDS	Paint System Data Sheet
SFPG	Square Feet Per Gallon
SFPGPC	Square Feet Per Gallon Per Coat
SP	Surface Preparation
SSPC	Steel Structures Painting Council

1.5 REFERENCE STANDARDS

A. This specification recognizes AWWA, NACE, and SSPC standards as minimum industry standards and they are referenced for purpose of conformance, except where modified in this section. The requirements of this specification section have been written to a higher design standard with the intent of achieving a long-term coating performance of 100 years.

NACE SP0188	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
NACE RP-0274	High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation.
SSPC-SP-1	Solvent Cleaning Surface Preparation
SSPC-SP-2	Hand Tool Cleaning Surface Preparation
SSPC-SP-3	Power Tool Cleaning Surface Preparation
SSPC-SP-5	White metal Abrasive Blast Surface Preparation
SSPC-SP-6	Commercial Abrasive Blast Surface Preparation
SSPC-SP-10	Near White Metal Abrasive Blast Surface Preparation
SSPC-SP-11	Power Tool Cleaning to Bare Metal
SSPC-SP-13	Surface Preparation of Concrete

1.6 SUBMITTAL REQUIREMENTS

A. Contractor submittals shall be made in accordance with Section 01 33 20 of these Specifications.

B. Shop Drawings: Catalog cuts and other information for all products proposed. Provide copy of approved coating system submittals to the coating applicator.

C. Quality Control Submittals: Furnish the following:
   1. Applicator's Experience with list of references substantiating compliance.
   2. Coating manufacturer's certification stating the individual coating applicators have met the qualification certification requirements as specified this section.
   3. Coating manufacturer shall provide a copy of the manufacturer’s coating application quality assurance manual.

4. If the manufacturer of field-applied coating differs from that of the shop applied primer, provide written confirmation from both manufacturers' that the two coating materials are compatible.

D. Product Data: Furnish the following Data Sheets:
   1. For each paint system used herein, furnish a Paint System Data Sheet (PSDS), Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system, except for products applied by equipment manufacturers. A sample PSDS form is appended at the end of this section.
   2. The required information shall be submitted on a system-by-system basis.
   3. The Contractor shall also provide copies of the paint system submittals to the coating applicator.
   4. Indiscriminate submittal of manufacturer's literature only is not acceptable.

E. Where ANSI/NSF Standard 60 and 61 approvals is required, submit ANSI/NSF certification letter for each coating in the system indicating product application limits on size of tank or piping, dry film thickness, number of coats, specific product tested, colors certified, and approved additives.

F. Provide TCLP test data for lead and other regulated heavy metals in non-recyclable, slag type abrasive blast media to be used on the project. Acceptable abrasive test data shall indicate the abrasive manufacturer, location of manufacture, and media gradation and type. Surface preparation will not be permitted to begin until acceptable test data has been submitted.

1.7 QUALITY ASSURANCE

A. Coating Applicator's Experience and Certification:
   1. Coating Application Company and coating application supervisor (Certified Applicator) shall have a minimum of 5 years' experience applying the specified coating system.
   2. Coating application personnel, whom have direct coating application responsibility, shall have a minimum of 2 years practical experience in application of the indicated coating system.
   3. Coating applicator shall be certified by the coating manufacturer as an approved applicator.

B. Continuity of Contractor: Contractor's site supervisor shall be coordinated with the Engineer. Any replacement of the supervisor on site will require notification of Engineer 72 hours in advance, and will be subject to approval by the Owner.

C. Coating and/or lining manufacturer shall provide a technical representative to visit the jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and these Specifications, and as may be necessary to resolve field problems attributable to, or associated with, the manufacturer's products furnished under this Contract.

1.8 WARRANTY

A. The Contractor and coating manufacturer shall jointly and severally warrant to the Owner and guarantee the work under this section against defective workmanship and materials for a period of 2 year(s) commencing on the date of final acceptance of the work.

1.9 ENGINEER OBSERVATIONS

A. The Contractor shall give the Owner Representative notice a minimum of 14 days prior to start of work for scheduling shop or field observation.

B. Provide Owner Representative a minimum 3 days' notice for actual start of surface preparation and coating application work.

C. Provisions shall be made to allow Owner's representative full access to facilities and appropriate documentation regarding coating application.

D. Observation by the Owner's representative or the waiver of observation of any portion of the work shall not be construed to relieve the Contractor of his responsibility to perform the work in accordance with these Specifications.

E. Materials shall be subject to testing for conformance with this specification as the Owner's representative may elect, prior to or during incorporation into the work.

F. Perform work in the presence of ENGINEER, unless Engineer grants prior approval to perform such work in Engineer's absence. Approval to perform work in the Engineer's absence is limited to the current day unless specifically noted to extend beyond the completion of the workday.

PART 2 PRODUCTS

2.1 GENERAL

A. Coatings and linings will be stored and handled per manufacturer's written directions.

B. All metallic surfaces shall be prepared and coated in accordance with referenced standards, written instructions of the coating or lining manufacturer, and these specifications, whichever is more stringent, unless specified otherwise.

C. Coatings shall be the product of a single manufacturer. Product substitutions during the project will not be permitted, without ENGINEER approval.

2.2 PAINT DELIVERY, STORAGE, AND HANDLING

A. Delivered paint to the project site in unopened containers that plainly show, at the time of use, the designated name, date of manufacture, color, and name of manufacturer.

B. Stored paints in a suitable protected area that is heated or cooled as required to maintain temperatures within the range recommended by the paint manufacturer.

C. Shipping:
   1. Where shop finish coated or primed items are to be shipped to the jobsite, protect coating from damage. Batten coated items to prevent abrasion.
   2. Use nonmetallic or padded slings and straps in handling.
   3. Items will be rejected for excessive damage.

2.3 PAINT AND COATINGS MANUFACTURERS

A. A manufacturer letter code as follows will be found following the generic descriptions of materials outlined in the Specifications. Address is that of the general offices. Contact these offices for information regarding the location of representative nearest the project site.

B. MANUFACTURER CODE A - COATINGS MANUFACTURERS (Able to supply most heavy-duty industrial coatings and architectural paints):

   1. Carboline Coatings Company, St. Louis, MO.
   2. ICI Devoe Coatings Company, Louisville, KY.
   3. International Coatings,
   4. Pittsburgh Paints (PPG), Pittsburgh, PA.
   5. Sherwin Williams, Cleveland, OH
   6. Tnemec Coatings, Kansas City, MO

2.4 PAINT MATERIALS

A. Products shall meet federal, state, and local requirements limiting the emission of volatile organic compounds. Specific information may be secured through the local office of the Air Pollution Control Officer.

B. Materials Including Primer and Finish Coats: Produced by same paint manufacturer.

C. Thinners, Cleaners, Driers, and Other Additives: As recommended by paint manufacturer of the particular coating. Where coatings are required to meet ANSI/NSF Standard 60 and 61, addition of thinners, driers, and other paint additives not approved under the ANSI/NSF certification letter will not be permitted without written approval from the Engineer.

D. Paint products are listed according to their approximate order of appearance in the paint systems. The letter designating the manufacturer code refers to Article PAINT AND COATING MANUFACTURERS.

Products	Description
Epoxy, NSF	Amine or polyamine epoxy coating, two parts, suitable for immersion service, 75% volume solids minimum, capable of 4 to 8 MDFT per coat, approved for potable water contact in conformance to ANSI/NSF Standard 60 and 61, and suitable for the application temperatures and conditions. MANUFACTURER CODE: A
Epoxy	Polyamine or polyamide epoxy, two parts, suitable for immersion service, 75% volume solids minimum, capable of 4 to 8 MDFT per coat, and suitable for the application temperatures and conditions. MANUFACTURER CODE: A
Polysiloxane	Acrylic polysiloxane hybrid coating, single component, suitable for shop or field application at 32 degrees F, minimum, recoat window of not less than 12 months with preference for products with unlimited overcoat capability, solids content of 85% minimum, high gloss, and tintable colors. Tinted colors shall be capable of storage for 30 days or longer prior to application. Coating shall be capable of spray, roller, or brush application on all metal substrates and specified prime and intermediate coats. MANUFACTURER CODE: A
Rust-Inhibitive Primer	Single-package steel primers with anti-corrosive pigment loading; may be alkyd, vinyl, epoxy ester, chlorinated rubber. MANUFACTURER CODE: A-B
Inorganic Zinc Primer	Solvent or water based, 14 lbs. metallic zinc content per gallon minimum; unlimited recoat window, conform to manufacturer's recommended top coats as specified herein. MANUFACTURER CODE: A
Wash Primer	Vinyl butyral acid or equivalent coating for enhancing finish coat adhesion to galvanized steel surfaces. MANUFACTURER CODE: A
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish, suitable for continuous dry service at 200 degrees F without discoloration or peeling. MANUFACTURER CODE: A

2.5 COLORS

A. Provide as selected by the Owner.

B. Formulated with colorants free of lead, lead compounds, or other materials which might be affected by the presence of hydrogen sulfide or other gas likely to be present at the project.

C. Proprietary identification of colors is for identification only. Any authorized manufacturer may supply matches.

D. Equipment Colors:
   1. Equipment shall be meant to include the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
   2. Paint non-submerged portions of equipment in the same color as the process piping it serves, except as itemized below:
      a. Dangerous parts of equipment and machinery: OSHA Orange
      b. Fire protection equipment and Apparatus: OSHA Red
      c. Radiation hazards: OSHA Purple
      d. Physical hazards in normal operating area: OSHA Yellow
   3. Fiberglass reinforced plastic (FRP) equipment with an integral colored gel coat does not require painting, provided the color is as specified.

E. Pipe Identification Painting:
   1. Color code non-submerged metal piping except electrical conduit. Paint fittings and valves the same color as the pipe.
   2. Piping color coding: In accordance with the Piping Schedule in Section 40 05 53 - Identification for Process Piping, as shown.
   3. Pipe supports: Mild steel, painted No. 70 light gray as specified in ANSI Z35.1.
   4. Fiberglass reinforced plastic (FRP) pipe and polyvinyl chloride (PVC) pipe located outside of buildings and enclosed structures will not require painting, except as noted.

F. Labels for Piping:
   1. Identification labels shall bear the full piping system name as specified in the Piping Schedule Section 40 05 53 - Identification for Process Piping.
   2. Install separate flow directional arrows with each label.
   3. Include black lettering on OSHA safety yellow self-adhesive vinyl or vinyl cloth.
   4. Lettering height: Meet ANSI A13.1.
   5. Label and Adhesive: Long lasting, resistant to moisture, oils, solvents, and weathering, meeting OSHA requirements.

2.6 QA/QC TESTING AND INSPECTION

A. General
   1. Applicator shall inspect and test the coating system in accordance with referenced standards and these specifications, whichever is more stringent.
   2. Quality control testing as specified in AWWA standards are minimum industry standards and it is the intent of this specification to provide a higher level of quality control for the objective of achieving maximum coating performance.
   3. If any conflict between this specification and referenced standards occurs, the more stringent requirement shall apply and any interpretation of this requirement or results shall be with the objective of achieving maximum coating performance.
   4. The frequency of the testing shall be determined by the applicator, but shall not be less than the requirements of this specification.

B. Surface Profile Testing
   1. Surface profile of abrasive blasted surfaces to be tested with “Press-O-Film” tester tape or equivalent in accordance with NACE RP287.

2. Tester tape shall be suitable for the intended profile height.
3. Profile shall be measured to a minimum tolerance of 0.1 mils, maximum.
4. Electronic surface profilometer shall be used, where deemed necessary, to verify tester tape measurements.

C. Adhesion testing: As directed by the Engineer for assessing coating application problems.

D. Holiday Testing
1. Holiday tests on polyurethane coatings or linings will be conducted on the completed coating or lining after cure or 24-hours, whichever is less, using a high voltage spark test in accordance with NACE SP-0188 and these specifications.
2. Coating thickness used for high voltage holiday testing setting shall be the average dry coating thickness.

E. Dry Film Thickness Testing
1. Coatings shall be tested for dry film thickness using a properly calibrated magnetic pull off, eddy current, or ultrasonic equipment.
2. Coating thickness measurements shall be conducted as necessary and without limitation. Testing conformance to the requirements of SSPC PA-2 is specifically excluded from this specification.

PART 3 EXECUTION

3.1 GENERAL

A. The intention of this specification is for all existing and new, interior and exterior surfaces are painted, whether specifically mentioned or not, except as modified herein. Concealed structural steel surfaces shall receive prime coat only unless modified herein. Exterior concrete surfaces will not be painted unless specifically indicated hereinafter.

B. Surface preparation and coating application shall be in conformance with these specifications and the coating manufacturer’s written product data sheets and written recommendations of the manufacturer’s technical representative. Where conflicts occur between the manufacturer’s recommendations and these specifications, the more stringent of the two shall apply unless otherwise approved by the Engineer.

C. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating for any purpose until completion of curing cycle.

3.2 REGULATORY REQUIREMENTS

A. Meet federal, state, and local requirements limiting the emission of volatile organic compounds and worker exposures.

B. Protect workers and comply with applicable federal, state, and local air pollution and environmental regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, coating application and dust prevention including, but not limited to the following Acts, Regulations, Standards, and Guidelines:
   1. Clean Air Act
   2. National Ambient Air Quality Standard
   3. Resource Conservation and Recovery Act (RCRA)

C. Comply with applicable federal, state, and local regulations for confined space entry.

D. Provide and operate equipment that meets explosion proof requirements.

3.3 ENVIRONMENTAL CONDITIONS

A. Do not perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent, whenever surface temperature is less than 5 degrees F above the dew point of the ambient air.

B. Surface preparation power tools and blast equipment shall contain dust collection equipment that will prevent discharge of dust particles into the atmosphere.

C. Do not apply paint when:
   1. Surface temperatures exceeds the maximum or minimum temperature recommended by the paint manufacturer,
   2. In dust, smoke-laden atmosphere, damp or humid weather, or under conditions which could cause icing on the metal surface.
   3. When it is expected that surface temperatures will drop below 5 degrees above dew point within 8 hours after application of coating.

3.4 DEHUMIDIFICATION

A. Where environmental conditions cannot be met or controlled, Contractor shall provide and operate desiccant dehumidification equipment to maintain environmental conditions for 24 hours a day during abrasive blasting and coating application and cure. Liquid, granular, or loose lithium chloride drying systems will not be acceptable.

B. Contractor shall provide dehumidification equipment sized to maintain dew point temperature 17 degrees or more below surface temperature of metal surfaces to be cleaned and coated. System shall provide ventilation within the environmentally controlled areas as required for the following requirements:
   1. One air exchange per hour, minimum,
   2. Maintenance of personnel exposures limits (PEL) at 50 percent of OSHA PEL limits for all chemicals used in the performance of the work, and
   3. Maintenance of lower explosive limits (LEL) to less than 50 percent of the most volatile solvent used in the performance of the work.

C. Dehumidification equipment type, size, air flow, and power requirements shall be designed by a qualified company knowledgeable in dehumidification equipment, and its operation based on project requirements and anticipated seasonal weather

conditions for the project schedule. Design to include evaluation of existing conditions, humidity, and temperature, proper air exchange requirements, ventilation requirements, ducting requirements for adequate air flow, and any other issues necessary to achieve the specified performance and environmental conditions throughout the duration of the project.

D. Contractor to submit written recommendations from dehumidification subcontractor for bulkhead locations, bulkhead venting, duct work for each bulkhead section, any secondary ventilation requirements for coating cure, dust collection equipment CFM requirements, and drying requirements for blast hose compressed air necessary to maintain environmental control as specified herein.

E. Dehumidification subcontractor shall either operate the equipment or provide training to Contractor on the proper operation and setup of dehumidification equipment. Dehumidification subcontractor shall provide a technical representative on site for a minimum of two 8-hour days to ensure proper operation of the equipment, achievement of desired environmental control, and to ensure Contractor can properly setup, operate, monitor, and maintain the equipment.

F. Dehumidification shall be operated in a manner that prevents all condensation or icing throughout surface preparation and coating application and cure.

G. Reblasting of flash rusted metal surfaces or removal of damaged coatings, as a result of equipment malfunction, shutdown, or other events that result in the loss of environmental control, will be at the sole expense of the Contractor. Cleaned metal surfaces subject to flash rusting shall be cleaned to the same cleanliness as prior to the flash rust formation and shall be approved by the Engineer.

H. Contractor shall monitor ambient temperature, humidity, dew point temperature, and pipe surface temperature both outdoors and within the work area at the start, midpoint, and end of each work shift, minimum, but not greater than 5 hours between measurements.

I. Daily environmental condition monitoring and maintenance of the equipment shall be documented in writing and posted near the equipment for review by the Engineer.

3.5 VENTILATION AND ILLUMINATION

A. Adequate illumination shall be provided while work is in progress. Whenever required by the inspector, the Contractor shall provide additional illumination and necessary supports to cover all areas to be inspected. The level of illumination for inspection purposes shall be determined by the inspector.

B. Ventilation shall be used to control potential dust and hazardous conditions within the tank. Ventilation flow rates shall be in accordance with OSHA regulations and as required to reduce air contamination to nonhazardous conditions.

3.6 SURFACES NOT REQUIRING PAINTING

A. Unless otherwise stated herein or shown, the following areas or items will not require painting:
   1. Concrete and masonry surfaces
   2. Nonferrous and corrosion-resistant ferrous alloys such as copper, bronze, monel, aluminum, chromium plate, atmospherically exposed weathering steel, and stainless steel, except where:
      a. Required for electrical insulation between dissimilar metals.
      b. Aluminum and stainless steel are embedded in concrete or masonry, or aluminum is in contact with concrete or masonry.
      c. Color coding of equipment and piping is required.
   3. Nonmetallic materials such as glass, PVC, wood, porcelain, and plastic (FRP) except as required for architectural painting or color coding.
   4. Prefinished electrical and architectural items such as motor control centers, switchboards, switchgear, panel boards, transformers, disconnect switches, acoustical tile, cabinets, elevators, building louvers, wall panels, etc.; color coding of equipment is required.
   5. Non-submerged electrical conduits attached to unpainted concrete surfaces.
   6. Cathodic protection anodes.
   7. Items specified to be galvanized after fabrication unless specifically required elsewhere or subject to immersion.
   8. Insulated piping and/or insulated piping with jacket will not require exterior coating, except as required for architectural painting or color coding.

3.7 PREPARATION OF SURFACES

A. Surface Preparation Inspection:
   1. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of paint manufacturer whose product is to be applied.
   2. Provide Engineer minimum 3 days' notice prior to start of surface preparation work or coating application work.
   3. Perform such work only in the presence of Engineer, unless Engineer grants prior approval to perform such work in Engineer's absence.

B. Metal Surface Preparation:
   1. General:
      a. Do not perform a surface preparation blast prior to submission of samples. Workmanship for metal surface preparation as specified shall meet current Steel Structures Painting Council (SSPC) Specifications as follows:
         (1) Solvent Cleaning: SP 1
         (2) Hand Tool Cleaning: SP 2
         (3) Power Tool Cleaning: SP 3
         (4) White Metal Blast Cleaning: SP 5
         (5) Commercial Blast Cleaning: SP 6
         (6) Brush-Off Blast Cleaning: SP 7
         (7) Pickling: SP 8
         (8) Near-White Blast Cleaning: SP 10
         (9) Bare Metal Power Tool Cleaning: SP 11

b. All surface preparation shall be assumed to be on a SSPC Grade A steel surface condition, unless specifically noted otherwise.
c. Wherever the words "solvent cleaning", "hand tool cleaning", "wire brushing", or "blast cleaning", or similar words of equal intent are used in these Specifications or in paint manufacturer's specifications, they shall be understood to refer to the applicable SSPC Specifications listed above.
d. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply. Wet blasting methods shall be approved by the Engineer.
e. Hand tool clean areas that cannot be cleaned by power tool cleaning.

2. Welds and adjacent areas:
   a. Prepared such that there is:
      (1) No undercutting or reverse ridges on the weld bead.
      (2) No weld spatter on or adjacent to the weld or any other area to be painted.
      (3) No sharp peaks or ridges along the weld bead.
   b. Grind embedded pieces of electrode or wire flush with the adjacent surface of the weld bead.
3. Preblast Cleaning Requirements:
   a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
   b. Cleaning methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
   c. Clean small isolated areas as above or solvent cleaned with suitable solvents and clean cloths.
   d. Round or chamfered all sharp edges and grind smooth burrs, jagged edges, and surface defects.
4. Blast Cleaning Requirements:
   a. General:
      (1) Type of Equipment and Speed of Travel: Designed to obtain specified degree of cleanliness.
      (2) Select type and size of abrasive to produce a surface profile that meets the coating manufacturer's recommendations for the particular coating to be applied or not less than 20 percent of the specified coating thickness, whichever is more stringent.
      (3) Meet applicable federal, state, and local air pollution control regulations for blast cleaning and disposition of spent aggregate and debris.
      (4) Do not reuse abrasive, unless abrasive is recyclable steel grit or shot abrasive.
   b. Shop Blasting
      (1) Notify Engineer at least 7 days prior to start of shop blast cleaning to allow for inspection of the work during surface preparation and shop application of paints. Work shall be subject to the Engineer's approval before shipment to the jobsite.
      (2) Items such as structural steel, metal doors and frames, metal louvers, and similar items as reviewed by the Engineer may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternate

to shop blast cleaning. Blast clean and prime in accordance with these Specifications.

c. Field Blasting
   (1) Perform sandblasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed. Materials, equipment, procedures, shall meet requirements of Steel Structures Painting Council.
   (2) Field blasting in areas with electrical or mechanical equipment, within buildings, or on coated surfaces with lead paint greater than 2,000 mg/L total lead shall be performed with dustless abrasive systems such as "Sponge-Jet", dry ice abrasive blasting.

5. Post-Blast Cleaning and Other Cleaning Requirements:
   a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wiped with a tack cloth.
   b. Paint surfaces the same day they are sandblasted. Reblast surfaces that have started to rust before they are painted.

C. Concrete Surface Preparation:
   1. Do not begin until 30 days after the concrete has been placed.
   2. Remove grease, oil, dirt, salts or other chemicals, loose materials or other foreign matter by solvent, detergent, or other suitable cleaning methods.
   3. Clean concrete using mechanical or chemical methods for the degree of cleaning specified for the coating system in accordance with SSPC SP-13, Surface preparation of Concrete.
   4. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to coating.
   5. Bug holes, air pockets, and other voids in the concrete will be filled or patched in chemical exposure areas, secondary containment, and where specifically required.
   6. Concrete Surface Preparation Inspection:
      a. Adhesion Testing:
         (1) Tensile testing of the surface preparation shall be performed by the Engineer as necessary using Type 4 or Type 5 pneumatic adhesion testing equipment in accordance with ASTM D4541 using 2-inch diameter dollies for concrete surface adhesion testing.
         (2) Applied coating greater than 20 mils in thickness or with a tensile strength greater than 2,500 psi shall be scored for concrete adhesion testing.
         (3) Adhesive failure greater than 50 percent of the dolly surface area shall indicate inadequate surface preparation.
         (4) Cohesive failures which result in loss of sound concrete will be acceptable provided the loss is greater than 50 percent of the dolly surface area.
         (5) Low adhesion cohesive failures with a thin layer of concrete due to weak concrete or laitance over 50 percent of the dolly surface will be rejected.
      b. Concrete Soundness:

(1) Concrete soundness shall be determined using the scratching or hammer impact methods as defined in SSPC SP-13.

c. Moisture Content:

(1) Moisture shall be tested as Specified in SSPC SP-13 and shall not exceed the moisture content recommended by the coating manufacturer.

D. Brush-off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet SSPC-SP 7, Brush-off Blast Cleaning and shall achieve a profile on the coating equivalent to 80 grit sandpaper with no exposed metal. Profile shall be uniform over the surface with no glossy areas visible.
2. Where metal substrate is exposed, Contractor shall apply full coating system as specified for new metal surfaces.
3. Repair or replace surfaces damaged by blast cleaning, where damage is defined as visible metal substrate. If less than 5 percent of prepared surface has the metal substrate visible, the coating shall be repaired by application of a brush applied intermediate coat. If greater than 5 percent the coating shall be fully removed to meet the specified surface cleanliness and recoated with the specified coating system.
4. Abrasive: Either conventional abrasive blasting with sand, grit, or nut shells or specialized abrasive blasting. Abrasives shall be 60 mesh grit, maximum.
5. Select various surface preparation parameters such as size and hardness of the abrasive, nozzle size, air pressure, and nozzle distance from the surface such that the surface is cleaned without pitting, chipping, or other damage.
6. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
7. The Engineer shall approve trial blast cleaned area and shall use area as a representative sample of surface preparation.

E. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by the use of solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods which involve a solvent or cleaning action.
2. Method meets SSPC-SP 1.

3.8 PROTECTION OF MATERIALS NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering the motors.

3.9 PAINT MIXING

A. Multiple-component coatings:
   1. Prepare using all of the contents of the container for each component as packaged by the paint manufacturer.
   2. No partial batches will be permitted.
   3. Do not use multiple-component coatings that have been mixed shall not be used beyond their pot life.
   4. Provide small quantity kits for touchup painting and for painting other small areas.
   5. Mix only components specified and furnished by the paint manufacturer.
   6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.
   7. Fast set or plural component products shall be applied using an appropriate multipart pump that properly mixes both components at the recommended ratio using equipment recommended by the coating manufacturer. Hot mixing of fast set or plural component products will not be permitted.

B. Keep paint materials sealed when not in use and provide nitrogen blanket on fast set, plural, or moisture cured coatings on opened product containers when stored or not in use more than 8 hours.

C. Where more than one coat of a material is applied within a given system, alternate color to provide a visual reference that the required number of coats have been applied.

3.10 APPLICATION OF PAINT

A. General:
   1. Inspection: Schedule with Engineer in advance for cleaned surfaces and all coats prior to the succeeding coat.
   2. Contractor is responsible for determining compatibility of shop applied coating with the final field applied coating.
   3. Apply coatings in accordance with the paint manufacturer's recommendations. Allow sufficient time between coats to assure thorough drying of previously applied paint.
   4. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
   5. Paint units to be bolted together and to structures prior to assembly or installation.
   6. Shop Primed or Factory Finished Surfaces:
      a. Inspection: Schedule with Engineer in advance for shop primed or factory-finished items delivered to jobsite for compliance with these Specifications.
      b. Hand or power sand areas of chipped, peeled, or abraded coating, feathering the edges. Follow with a spot primer using specified primer.

c. For two-package or converted coatings, consult the coatings manufacturer for specific procedures as relates to top coating of these products.
d. Prior to application of finish coats, clean shop primed surfaces of dirt, oil, and grease, and apply a mist coat of specified primer, 1.0 mil dry film thickness.
e. After welding, prepare and prime holdback areas as required for the specified paint system. Apply primer in accordance with manufacturer's instructions.

7. Manufacturer Applied Paint Systems:
   a. Repair abraded areas on factory-finished items in accordance with the equipment manufacturer's directions.
   b. Carefully blend repaired areas into the original finish.
   c. Contractor is responsible for determining compatibility of manufacturer applied coating with the field applied final coating.

B. Application Safety
1. Performed painting in accordance with recommendations of the following:
   a. Paint manufacturer's instructions.
   b. NACE contained in the publication, Manual for Painter Safety.
   c. Federal, state, and local agencies having jurisdiction.
2. Contractor will be solely and completely responsible for condition of the project site, including safety of all persons (including employees) and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. Safety provisions will conform to U.S. Department of Labor, Occupational Safety and Health Act, any equivalent state law, and all other applicable federal, state, county, and local laws, ordinances, and codes.
3. Contractor will comply with all safety-training requirements promulgated or required for this project.

C. Film Thickness:
1. Coverage is listed as either total minimum dry film thickness in mils (MDFT) or the spreading rate in square feet per gallon (SFPG). Per coat determinations are listed as MDFTPC or SFPGPC.
2. Applied coating system film thickness per coat shall be applied at the specified coating thickness or the manufacturer’s recommended minimum thickness, whichever is greater. Where the manufacturer has not specified a minimum coating thickness on the product data sheets, the minimum recommended coating application thickness shall apply.
3. Maximum film build per coat shall not exceed the coating manufacturer's recommendations.

D. Stripe Coats:
1. Surfaces that are subject to immersion, condensing environments, or where specifically specified shall be stripe coated on all angles, edges, corners, threads, welds, and similar type surfaces.
2. Stripe coat shall be an extra coat of the intermediate coating material and shall be applied between the prime and intermediate coats.
3. The stripe coat shall be a separate coat from coats specified under the coating system.

4. Stripe coats shall be alternated in color like a full coat.

E. Number of coats:
   1. Apply specified number of coats, minimum, irrespective of the coating thickness.
   2. Additional coats may be required to obtain the minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.

F. Porous Surfaces, Such as Concrete, Masonry:
   1. Prime Coat:
      a. May be thinned to provide maximum penetration and adhesion.
      b. Type and Amount of Thinning: Determined by the paint manufacturer and is dependent on surface density and type of coating.
      c. Surfaces Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of the coating.

G. Existing Coated Surfaces:
   1. General:
      a. Equipment or components with shop primer or shop finish coated surfaces shall be reviewed with the Engineer to determine coating damage, repair methods, surface preparation requirements, and conformance with color uniformity, where required.
      b. All shop primed or finished coated surfaces shall be verified (by the Contractor) to be chemically compatible with field applied finish coats.
      c. If a cured epoxy, polyurethane, or plural-component material is to be top coated, contact the coating manufacturer for additional surface preparation requirements. Existing coated surfaces shall be prepared as follows"
         (1) Existing coated surfaces shall be brush-off blasted as specified herein to remove all gloss and provide a uniform profile on existing coating for adhesion of subsequent coats.
         (2) Power or hand sanding will not be allowed as a surface preparation procedure for existing coatings, unless reviewed and approved by the Engineer.
         (3) Where coating manufacturer surface preparation recommendations conflict with this section, the more stringent requirements shall apply.
         (4) Profile shall be as specified for by the manufacturer or equivalent of 80 grit sandpaper; whichever is more stringent. Profile shall be visible and uniform over existing coated surfaces.
      d. All existing coated surfaces, where demolition of equipment was specified or required, shall be surface prepared, touch-up coating repairs completed, and a cosmetic overcoat applied using the specified coating system on all existing coated surfaces associated with the demolition work, unless otherwise specified.
      e. Existing coatings on immersed equipment shall be removed to bare metal and recoated with the specified coating system where demolition work was specified.
      f. Apply sealer/primer where recommended by coating manufacturer for coating compatibility.
   2. To be Recoated or Final Coated:

a. Detergent wash and freshwater rinse.
b. Perform touch-up repairs of existing coating.
c. Asphaltic varnish coated ductile iron pipe will require an application of a seal coat prior to the application of a cosmetic finish coat.

3. Touch-up Repairs:
   a. Clean loose, abraded, or damaged coatings to substrate by Power Tool (SP 3).
   b. Feather surrounding intact coating.
   c. Apply one spot coat of the specified primer to bare areas overlapping the prepared existing coating.
   d. Apply one full finish coat of the specified primer or finish coat(s) overall.
4. Application of a Cosmetic Coat:
   a. The exact nature of shop-applied coatings is not known in all cases.
   b. Check compatibility by application to a small area prior to starting the coating.
   c. If lifting or other problems occur, request disposition from the Engineer.
   d. Cured epoxy, polyurethane, plural component materials or any other coating system that has exceeded its maximum recoat window shall be prepared as specified this section.

H. Damaged Coatings, Pinholes, and Holidays:
1. Feather edges and repaired in accordance with the recommendations of the paint manufacturer.
2. Repair fusion bonded coatings to be as recommended by the original applicator. Applicator shall provide liquid repair kits for this purpose as recommended by the coating manufacturer.
3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

I. Unsatisfactory Application:
1. If the item has an improper finish color, or insufficient film thickness, clean and topcoat surface with specified paint material to obtain the specified color and coverage. Obtain specific surface preparation information from the coating manufacturer.
2. Hand or power sand visible areas of chipped, peeled, or abraded paint and feather the edges. Follow with primer and finish coat in accordance with the Specifications. Depending on the extent of repair and its appearance, a finish sanding and topcoat may be required.
3. Evidence of runs, bridges, shiners, laps, or other imperfections shall be cause for rejection.
4. Repair defects in coating system per written recommendations of coating manufacturer.
5. Leave all staging up until the Engineer has inspected the surface or coating. Replace staging removed prior to approval by Engineer.

3.11 COATING INSPECTION

A. General
1. Film thickness measurements and electrical inspection of the coated surfaces:
2. Perform with properly calibrated instruments.

3. Recoat and repair as necessary for compliance with the Specifications.
4. All coats will be subject to inspection by the Engineer and the coating manufacturer's representative.
5. Visually inspect concrete, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
6. Give particular attention to edges, angles, flanges, and other areas where insufficient film thicknesses are likely to be present and ensure proper milage in these areas.

B. Coating Thickness Testing:
1. Engineer shall conduct coating thickness testing as necessary and without limitation. Testing conformance to the requirements of SSPC PA-2 is specifically excluded from this specification.
2. Measure coating thickness specified in mils with a magnetic type dry film thickness gauge as specified.
3. Check each coat for the correct milage. Do not make measurement before a minimum of 8 hours after application of the coating.
4. Tests for concrete coating thickness shall be with a Tooke Gauge, a destructive test. Contractor shall repair coating after thickness testing.

C. Coating Continuity Testing
1. Holiday detect coatings with high voltage units in accordance with NACE RP0188. High voltage detector shall have adjustable voltages in 100 volt increments and shall be operated in accordance with the manufacturer’s instructions and the specified standard.
2. Use of an electrical holiday detector, low voltage, wet sponge type holiday detector will be permitted for coating systems less than 20 mils total dry film thickness and are not for immersion or condensing environments.
3. Holiday detect coatings on pipe for buried application with high voltage spark tester in accordance with NACE RP0274.

3.12 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroyed at the end of each day.

B. Upon completion of the work, remove staging, scaffolding, and containers from the site or destroyed in a legal manner.

C. Completely remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

D. Damages due to over spray on buildings, vehicles, trees, or other surfaces not specified to be painted would be the responsibility of the Contractor.

3.13 MANUFACTURER' SERVICES

A. Furnish paint manufacturer's representative to visit jobsite at intervals during surface preparation and painting as may be required for product application quality

assurance, and to determine compliance with manufacturer's instructions and these specifications, and as may be necessary to resolve field problems attributable to, or associated with, manufacturer's products furnished under this Contract.

3.14 PROTECTIVE COATING SYSTEMS AND APPLICATION SCHEDULE:

A. Unless otherwise shown or specified in these Specifications painted or coated the work in accordance with the following application schedule.

B. In the event of discrepancies or omissions in the following, request clarification from the Engineer before starting the work in question.

System No.	Title
1	SUBMERGED METAL - IMMERSION
4	EXPOSED METAL – HIGHLY CORROSIVE
5	EXPOSED METAL – ATMOSPHERIC
6	EXPOSED METAL – INTERIOR SPACE
7	NONEXPOSED METAL – INTERIOR SPACE
8	BURIED METAL - MISCELLANEOUS
10	GALVANIZED METAL
21	EPOXY FLOOR, CONCRETE
27	ALUMINUM AND DISSIMILAR METAL INSULATION
29	FUSION BONDED COATING

C. System No. 1 - Submerge Metal, Immersion

1. Surface Preparation and Coating System

Surface Prep.	Coating Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 5) Cement Mortar Prep: see Interior Linings, this section	Epoxy, NSF	3 coats, 16 MDFT

2. Application:
   a. All metal surfaces subject to immersion or contact with potable water.
   b. Use on the following areas of exposed pipe or metal surfaces:
      (1) Finished Water, venting, and other pipes into the Clearwell.
      (2) Waste pipes into the sludge drying beds.
      (3) All steel pipe without a cement mortar lining.
3. Material Requirements:

a. Polyamide Epoxy: Amine or polyamine epoxy coating, two parts, suitable for immersion, application temperatures, and environmental exposures and conditions, 75% volume solids minimum, capable of 4 to 8 MDFT per coat.
b. Epoxy coating shall be NSF certified for potable water contact in conformance to ANSI/NSF Standard 60 and 61.

4. Special Requirements:
   a. Epoxy coating applied to immersed surfaces that contact potable water shall be NSF certified for potable water contact.
   b. NSF certified fusion bonded epoxy linings will be permitted as alterative lining for small diameter pipes, valves, and couplings. FBE coating to be applied as specified for FBE coatings this section and in accordance with the manufacturer's recommendations.
   c. All welds, angles, edges, and bolted connections shall be stripe coated as specified this section.

D. System No. 4 - Exposed Metal, Highly Corrosive

1. Surface Preparation and Coating System

Surface Prep.	Coating Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	Inorganic Zinc Rich Primer	1 coat, 3.0 to 4.0 DFT
	Epoxy	1 coat, 4 MDFT
	Polyurethane Enamel	2 coats, 6 to 8 DFT
	Or	
	Polysiloxane	2 coats, 4 to 6 DFT

2. Application:
   a. All exposed metal surfaces, new and existing, located inside of vaults or intermittently wet areas.
   b. Use on the following areas:
      (1) All exposed pipe and metal surfaces within buried vaults.
      (2) All exposed pipe in the water treatment room (not including structural steel).
   c. Contractor choice of top coat material shall not be changed. Only one top coat materials will be permitted on the project.
3. Special Requirements:
   a. Surface preparation and primer shall be shop applied to all surfaces prior to installation.
   b. DFT thicknesses greater than manufacturer's recommendations shall be subject to rejection and removal.
   c. Intermediate and top coats shall be field applied after installation.
   d. All shop primed or finish coated surfaces shall be prepared as an existing coated surface as specified herein and shall be top coated with intermediate and/or finish coats as required to provide color uniformity throughout the vault or structure.

e. Color uniformity requirements shall apply to all components installed within the vault and visibly part of completed installation regardless of shop applied coating system.

E. System No. 5 - Exposed Metal, Atmospheric:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	Inorganic Zinc Rich Primer	1 coat, 2.5 MDFT
	Polysiloxane	2 coats, 6 MDFT

2. Application:
   a. Exposed metal surfaces, new and existing, located outside of structures and exposed to weather and the following specific surfaces unless otherwise specified.
   b. Use on the following items or surfaces:
      (1) All piping and metal surfaces within the pump room and garage shop areas.
      (2) All exposed/uncoated structural steel including the steel roof joists and galvanized steel roof decking in the treatment room and pump room, if not galvanized.

3. Special Requirements:
   a. All shop primed or finish coated surfaces shall be prepared as an existing coated surface as specified herein and shall be top coated with intermediate and/or finish coats as required to provide color uniformity.
   b. Color uniformity requirements shall apply to all components visibly part of the completed installation regardless of shop applied coating system.
   c. Galvanized steel surfaces shall be coated per the coating manufacturer's requirements.
   d. Polysiloxane coating to overlap buried pipe coating a minimum of 4 inches below top of concrete.
   e. Aliphatic polyurethane will not be allowed as a substitute for polysiloxane due to restrictive overcoat requirements.
   f. Dry film coating thickness of polysiloxane, including touch up repairs, shall not exceed the manufacturer's recommended maximum film thickness.

F. System No. 6 - Exposed Metal – Interior Space:
1. Surface Preparation and Coating System to be per Section 09 91 23 – Interior Painting, 3.5.B Steel Substrates
2. Application:
   a. Exposed metal surfaces.
   b. Use on the following items or surfaces:
      (1) Garage Area
3. Special Requirements:

a. All shop primed or finish coated surfaces shall be prepared as an existing coated surface as specified herein and shall be top coated with intermediate and/or finish coats as required to provide color uniformity.
b. Color uniformity requirements shall apply to all components visibly part of the completed installation regardless of shop applied coating system.
c. Galvanized steel surfaces shall be coated per the coating manufacturer's requirements.
d. The steel beams and steel columns in this area are to be fireproofed per BXUV.N640 and BXUV.Y616, respectively. Coatings to be compatible with these fireproofing systems.

G. System No. 7 - Nonexposed Metal – Interior Space:
1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Hand Tool Cleaning (SP 2)	Rust-Inhibitive Primer	1 coat, 3 MDFT

2. Application:
a. Exposed metal surfaces.
b. Use on the following items or surfaces:
(1) Above the Office Area all structural steel beams and steel joists.

H. System No. 8 - Buried Metal, General:
1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast or Centrifugal Wheel Blast (SP 10)	Wax Tape Coating	Wax tape as specified in Section 09 97 01, Pipeline Coating and Lining

2. Application:
a. All buried miscellaneous pipe, joints, fittings, and other pipe appurtenances shall be coated as specified under Section 09 97 01, Pipeline Coatings and Linings.
b. All buried, below grade portions of steel items, except buried stainless steel or ductile iron, unless otherwise specified.
3. Special Requirements:
a. None

I. System No. 10 - Galvanized Metal Conditioning:
1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1) Followed by Hand Tool (SP 2) or Power Tool (SP 3)	Wash Primer Finish Coats to Match Existing Paint	1 Coat, 0.4 MDFT As Required to Match Surrounding Area

2. Application:
   a. All galvanized surfaces requiring painting and the following specific surfaces unless otherwise specified.
3. Special Requirements:
   a. Sweep blast as specified this section, may be used in lieu of hand or power tool cleaning of galvanized surfaces provided Contractor can demonstrate that damage to the zinc coating will not result. Engineer approval of sweep blasting locations, methods, and surface cleanliness and profile results is required.
   b. See applicable coating systems for finish coating system and coating requirements based on area and/or surface to be coated.

J. System No. 21 Epoxy Floor, Concrete:
1. Surface Preparation and Coating System

Surface Prep.	Paint Materials	Min. Coats, Cover
Concrete	Epoxy	1st coat (thinned) 2 coats (unthinned) Total system 80 SFPG

2. Application:
   a. Use on the following areas:
      (1) The floors of all cast-in-place concrete vaults and decant pump vault.
      (2) The floors of the Chemical Areas (Chlorine, Caustic, Primary Coagulant, and Polymer Areas)
      (3) All other areas as shown on the Drawings or specified to receive, epoxy concrete floor coating.
3. Special Requirements:
   a. Epoxy coating to be applied in chemical areas to the height of the containment walls (18") and is to also include the walls and floors of the equipment pads within the chemical containment areas.
   b. Apply non-skid aggregate between coats on the Polymer Area floor and tote platform/stair concrete.
   c. For all other areas, epoxy coating to be applied a minimum of 6-inches onto walls, pipe supports, and any other metallic component attached to the floor or wall within the 6-inch limit. All areas above the 6-inch limit shall be masked, provide a straight-line demarking coated versus uncoated areas.
   d. Abrasively blast miscellaneous metal surfaces to an SSPC SP-10, near white blast, as specified this section.
   e. Prime coat of epoxy shall be a thinned coat of the epoxy coating to fill and seal the concrete before the final coats applied, per the coating manufacturer's requirements.

K. System No. 27 Aluminum and Dissimilar Metal Insulation:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Wash Primer	1 coat, 0.4 MDFT
	Epoxy	1 coat, 8 MDFT

2. Application:
   a. Use on all non-submerged concrete embedded aluminum surfaces, and the following specific surfaces unless otherwise specified.
   b. Use on the following surfaces:
      (1) All concrete embedded components of vault hatches
      (2) All concrete embedded surfaces where electrical isolation from concrete reinforcement is required.

L. System No. 29 Fusion Bonded Coating:
   1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10) or Acid Pickling (SP 8)	Fusion Bonded 100% solids Epoxy or Polyurethane	1 or 2 coats, 10 MDFT

2. Application:
   a. Use where specified.
   b. Use on the following items or surfaces:
      (1) Concrete embedded anchor bolts, except threads.
      (2) Removable handrail sleeves.
3. Special Requirements:
   a. System 1 may be used as alternative coating system at Contractor's option

(See PSDS form following this section)

PAINT SYSTEM DATA SHEET

Attached products' Technical Data Sheet (if applicable) to this sheet for each paint system submittal.

Paint System Number (from spec.):
Paint System Title (from spec.):
Coatings Manufacturer:
Representative:
Surface Preparation:

Paint Material (Generic)	**Product Name/Number Proprietary)**	**Min. Coats, Coverage**

Additional Information Required (check applicable items):

☐ ANSI/NSF Certification letter for each paint material listed above requiring ANSI/NSF Standard 60 and 61 approvals.

☐ Manufacturer's minimum and maximum recommended coating thickness per coat and for total coating system.

☐ Immersion coating cure requirements from minimum coating application temperature to 100 degrees in 15-degree temperature increments.

END OF SECTION

SECTION 09 91 13
EXTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes surface preparation and the application of paint systems on the following exterior substrates:
   1. Concrete.
   2. Steel.
   3. Galvanized metal.

B. Related Sections include the following:
   1. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
   2. Division 09 Section "Interior Painting" for surface preparation and the application of paint systems on interior substrates.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection: For each type of topcoat product indicated.

C. Samples for Verification: For each type of paint system and each color and gloss of topcoat indicated.
   1. Submit Samples on rigid backing, 8 inches (200 mm) square.
   2. Step coats on Samples to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

D. Product List: For each product indicated, include the following:
   1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
   2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.4 QUALITY ASSURANCE

A. MPI Standards:
   1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."

2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 PROJECT CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
1. Quantity: Furnish an additional 2 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Benjamin Moore & Co.
2. ICI Paints.
3. Kwal-Howells Paint.
4. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

A. Material Compatibility:
1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. Colors: As selected by Architect from manufacturer's full range.

C. Special Systems: See special system, including manufacturers and products listed for Steel Substrates in the Exterior Painting Schedule.

2.3 PRIMERS/SEALERS

A. Alkali-Resistant Primer: MPI #3.
   1. VOC Content: E Range of E3.

B. Bonding Primer (Water Based): MPI #17.
   1. VOC Content: E Range of E3.

C. Bonding Primer (Solvent Based): MPI #69.
   1. VOC Content: E Range of E3.

2.4 METAL PRIMERS

A. Alkyd Anticorrosive Metal Primer: MPI #79.
   1. VOC Content: E Range of E2.

B. Quick-Drying Alkyd Metal Primer: MPI #76.
   1. VOC Content: E Range of E3.

C. Waterborne Galvanized-Metal Primer: MPI #134.
   1. VOC Content: E Range of E3.

2.5 EXTERIOR LATEX PAINTS

A. Exterior Latex (Flat): MPI #10 (Gloss Level 1).
   1. VOC Content: E Range of E3.

B. Exterior Latex (Semigloss): MPI #11 (Gloss Level 5).
   1. VOC Content: E Range of E3.

C. Exterior Latex (Gloss): MPI #119 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).
   1. VOC Content: E Range of E3.

2.6 EXTERIOR ALKYD PAINTS

A. Exterior Alkyd Enamel (Flat): MPI #8 (Gloss Level 1).
   1. VOC Content: E Range of E1.

B. Exterior Alkyd Enamel (Semigloss): MPI #94 (Gloss Level 5).
   1. VOC Content: E Range of E2.

C. Exterior Alkyd Enamel (Gloss): MPI #9 (Gloss Level 6).
   1. VOC Content: E Range of E2.

2.7 QUICK-DRYING ENAMELS

A. Quick-Drying Enamel (Semigloss): MPI #81 (Gloss Level 5).
   1. VOC Content: E Range of E3.

B. Quick-Drying Enamel (High Gloss): MPI #96 (Gloss Level 7).
   1. VOC Content: E Range of E3.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Concrete: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
   1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
   2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.

F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions.
   1. Use applicators and techniques suited for paint and substrate indicated.
   2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 FIELD QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
   1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
   2. Testing agency will perform tests for compliance of paint materials with product requirements.
   3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces:
1. High-Build Latex System: MPI EXT 3.1L, applied to form dry film thickness of not less than 10 mils (0.25 mm).
   a. Prime Coat: As recommended in writing by topcoat manufacturer.
   b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
   c. Topcoat: High-build latex (exterior).

B. Steel Substrates:
1. Painting of exposed exterior steel includes preparation, shop primer, one field-applied undercoat and two field-applied finish coats.
2. Prep: SSPC SP-10 “near white blast cleaning”.
3. Shop Primer: Inorganic Zinc Coating (3 mils min.)
   a. Ameron: Dimetcote 9 Zinc.
   b. Sherwin-/Williams: Zinc Clad II
   c. Tnemec: Tnemec-Zinc.
   d. Valspar: MZ7 13-F-12
4. Undercoat: Epoxy Polyamide Undercoat (7 mils min.)
   a. Ameron: Amercoat 383 HS.
   b. Sherwin-Williams: B67 Series.
   c. Tnemec: 161 Series
   d. Valspar: 190 HB Epoxy.
   e.
5. Finish Coats (2 coats): Gloss Aliphatic (or Acrylic) Polyurethane (3 mils each coat, min.)
   a. Ameron: Amercoat 450 HS.
   b. Sherwin-Williams: B65 Series.
   c. Tnemec: Endura Shield 74 Series.
   d. Valspar: 40 Urethane Enamel.

C. Galvanized-Metal Substrates:
1. Alkyd System: MPI EXT 5.3B.
   a. Prime Coat: Cementitious galvanized-metal primer.
   b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
   c. Topcoat: Exterior alkyd enamel (semigloss).

END OF SECTION

SECTION 09 91 23
INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes surface preparation and the application of paint systems on the following interior substrates:
   1. Concrete masonry units (CMU).
   2. Steel.
   3. Galvanized metal.
   4. Gypsum board.

B. Related Sections include the following:
   1. Division 5 Sections for shop priming of metal substrates with primers specified in this Section.
   2. Division 6 Sections for shop priming carpentry with primers specified in this Section.
   3. Division 8 Sections for factory priming hollow metal doors and frames with primers specified in this Section.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection: For each type of topcoat product indicated.

C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.
   1. Submit Samples on rigid backing, 8 inches (200 mm) square.
   2. Step coats on Samples to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

D. Product List: For each product indicated, include the following:
   1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
   2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.4 QUALITY ASSURANCE

A. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 PROJECT CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
1. Quantity: Furnish an additional 2 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

B. To efficiently edit Part 2, first edit the Interior Painting Schedule in Part 3; then retain, delete, and insert appropriate products in Part 2 to correspond with paint systems specified in the Interior Painting Schedule.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Benjamin Moore & Co.
2. ICI Paints.
3. Kwal-Howells Paint.
4. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

A. Material Compatibility:
1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. Chemical Components of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions; these requirements do not apply to primers or finishes that are applied in a fabrication or finishing shop:
1. Flat Paints and Coatings: VOC content of not more than 50 g/L.
2. Nonflat Paints and Coatings: VOC content of not more than 150 g/L.
3. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
4. Restricted Components: Paints and coatings shall not contain any of the following:
   a. Acrolein.
   b. Acrylonitrile.
   c. Antimony.
   d. Benzene.
   e. Butyl benzyl phthalate.
   f. Cadmium.
   g. Di (2-ethylhexyl) phthalate.
   h. Di-n-butyl phthalate.
   i. Di-n-octyl phthalate.
   j. 1,2-dichlorobenzene.
   k. Diethyl phthalate.
   l. Dimethyl phthalate.
   m. Ethylbenzene.
   n. Formaldehyde.
   o. Hexavalent chromium.
   p. Isophorone.
   q. Lead.
   r. Mercury.
   s. Methyl ethyl ketone.
   t. Methyl isobutyl ketone.
   u. Methylene chloride.
   v. Naphthalene.
   w. Toluene (methylbenzene).
   x. 1,1,1-trichloroethane.
   y. Vinyl chloride.

C. Colors: Match Architect's samples.

2.3 BLOCK FILLERS

A. Interior/Exterior Latex Block Filler: MPI #4.

2.4 PRIMERS/SEALERS

A. Interior Latex Primer/Sealer: MPI #50.

B. Interior Alkyd Primer/Sealer: MPI #45.

2.5 METAL PRIMERS

A. Alkyd Anticorrosive Metal Primer: MPI #79.

B. Rust-Inhibitive Primer (Water Based): MPI #107.

C. Waterborne Galvanized-Metal Primer: MPI #134.

2.6 LATEX PAINTS

A. Interior Latex (Semigloss): MPI #54 (Gloss Level 5).

B. Interior Latex (Gloss): MPI #114 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
1. Concrete: 12 percent.
2. Masonry (Clay and CMU): 12 percent.
3. Wood: 15 percent.
4. Gypsum Board: 12 percent.
5. Plaster: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Clay Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content of surfaces or alkalinity of mortar joints to be painted exceed that permitted in manufacturer's written instructions.

F. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

G. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

I. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions.
1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms, in exposed ceilings, and occupied spaces including, but not limited to, the following:
   1. Mechanical Work:
      a. Uninsulated metal piping.
      b. Uninsulated plastic piping.
      c. Pipe hangers and supports.
      d. Tanks that do not have factory-applied final finishes.
      e. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
      f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
      g. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
   2. Electrical Work:
      a. Switchgear.
      b. Panelboards.
      c. Electrical equipment that is indicated to have a factory-primed finish for field painting.

3.4 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

A. CMU Substrates:
   1. Latex System: MPI INT 4.2A.
      a. Prime Coat: Interior/Exterior Latex Block Filler.
      b. Intermediate Coat: Interior latex matching topcoat.
      c. Top Coat: Interior latex (semigloss).

B. Non-Traffic Concrete Substrates:
   1. Latex System: MPI INT 3.1A.
      a. Prime Coat: Primer, alkali resistant, water-based.

b. Intermediate Coat: Interior latex matching topcoat.
c. Top Coat: Interior latex (semigloss).

C. Steel Substrates:
1. Water-Based Dry-Fall System: MPI INT 5.1C.
a. Prime Coat: Alkyd anticorrosive metal primer.
b. Topcoat: Latex dry fog/fall or Waterborne dry fall.
2. Alkyd System: MPI INT 5.1E.
a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Interior alkyd matching topcoat.
c. Topcoat: Interior alkyd (semigloss).

D. Galvanized-Metal Substrates:
1. Water-Based Dry-Fall System: MPI INT 5.3H.
a. Prime Coat: Waterborne dry fall.
b. Topcoat: Waterborne dry fall.
2. Latex Over Waterborne Primer System: MPI INT 5.3J.
a. Prime Coat: Waterborne galvanized-metal primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (semigloss).

E. Gypsum Board Substrates:
1. Latex System: MPI INT 9.2A.
a. Prime Coat: Interior latex primer/sealer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (semigloss).

END OF SECTION

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SECTION 09 96 00
HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and the application of high-performance coating system on the following substrates:
   1. Interior Substrates:
      a. Concrete, vertical and horizontal surfaces.
      b. Concrete masonry units (CMUs).

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.
   1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.

B. Samples: For each type of coating system and in each color and gloss of topcoat indicated.

1.3 QUALITY ASSURANCE

A. Mockups: Apply mockups of each coating system indicated to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. Upon approval of Architect, approved mockups may be incorporated into the finished project.
   1. Architect will select one surface to represent surfaces and conditions for application of each coating system.
      a. Wall surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
      b. Other Items: Architect will designate items or areas required.
   2. Final approval of color selections will be based on mockups.
      a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to products listed in the Exterior High-Performance Coating Schedule or Interior High-Performance Coating Schedule for the coating category indicated.

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:
   1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
   3. Products shall be of same manufacturer for each coat in a coating system, or approved by the finish coat manufacturer for use with their product(s).

C. Colors: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Concrete: 12 percent.
   2. Masonry (Clay and CMUs): 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

3.3 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

B. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Concrete Substrates, Vertical Surfaces:
   1. Epoxy, High-Build System MPI INT 3.1P:
      a. Prime Coat: High-build epoxy, matching topcoat (reduced).
      b. Intermediate Coat: High-build epoxy, matching topcoat.
      c. Topcoat: High-build epoxy, low gloss, MPI #108.

B. Concrete Substrates, Horizontal Surfaces.
   1. Epoxy, High-Build System MPI INT 3.2L:
      a. Prime Coat: High-build epoxy, matching topcoat (reduced).
      b. Intermediate Coat: High-build epoxy, matching topcoat.
      c. Topcoat: High-build epoxy, low gloss, MPI #108.

C. CMU Substrates:
   1. Epoxy, High-Build System MPI INT 4.2R:
      a. Prime Coat: Epoxy block filler, MPI #116.
      b. Intermediate Coat: High-build epoxy, matching topcoat.
      c. Topcoat: High-build epoxy, low gloss, MPI #108.

END OF SECTION

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SECTION 09 97 01
PIPELINE COATINGS AND LININGS

PART 1 GENERAL

1.1 WORK RESULTS

A. This section covers the work necessary to apply external coating and internal lining on ductile iron and steel pipe, field coating of joints, and shop and field repair of coating damage, complete.

B. Exposed ductile iron and steel pipe will be shop coated as specified in Section 09 90 01, Protective Coatings.

1.2 RELATED SECTIONS:

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.

C. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
   1. Section 01 33 20 - Submittal Procedures.
   2. Section 09 90 01 – Protective Coatings

1.3 GENERAL:

A. See section GENERAL CONDITIONS, which contain information and requirements that apply to the work specified and are mandatory for this project.

1.4 SUBMITTAL REQUIREMENTS

A. Contractor submittals shall be made in accordance with Section 01 33 20 of these Specifications.

B. Shop Drawings: Catalog cuts and other information for all products proposed. Provide copy of approved coating system submittals to the coating applicator.

C. Quality Control Submittals: Furnish the following:
   1. Applicator's Experience with list of references substantiating compliance.
   2. Coating manufacturer's certification stating the individual coating applicators have met the qualification certification requirements as specified this section.

3. Coating manufacturer shall provide a copy of the manufacturer's coating application quality assurance manual.
4. If the manufacturer of field-applied coating differs from that of the shop applied primer, provide written confirmation from both manufacturers' that the two coating materials are compatible.

1.5 QUALITY ASSURANCE

A. Coating Applicator's Experience and Certification:
   1. Coating Application Company and coating application supervisor (Certified Applicator) shall have a minimum of 5 years' experience applying the specified coating system.
   2. Coating application personnel, whom have direct coating application responsibility, shall have a minimum of 2 years practical experience in application of the indicated coating system.
   3. Coating applicator shall be certified by the coating manufacturer as an approved applicator.

B. Coating and/or lining manufacturer technical representative shall be present for a minimum of three days technical assistance and instruction at the start of coating and/or lining operations within the shop. During this visit, the technical representative shall observe surface preparation and coating application and conduct tests of the coating to insure conformance with application instructions, recommended methods, and conditions.

C. Coating and/or lining manufacturers technical representative shall be onsite for three working days, minimum, at the start of each construction season to inspect coating application and procedures in the field. During this visit, the technical representative shall observe surface preparation and coating application and conduct tests of the coating to insure conformance with application instructions, recommended methods, and conditions.

D. Technical representative shall provide a written report to the Engineer for each visit. Report shall include copies of test data collected, description of observations, and all recommended corrective actions. Report shall be submitted within 5 working days after the visit. When deemed necessary by the Engineer, work will not be permitted to proceed until the recommended corrective actions have been implemented. After all corrective recommendations have been completed; the manufacturer representative shall return and certify that the application complies with the manufacturer's coating application recommendations.

E. Additional visits by the manufacturer's representative shall be made at sufficient intervals during surface preparation and coating or lining as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions, and as may be necessary to resolve problems attributable to, or associated with, manufacturer's products furnished for this project.

1.6 ABBREVIATIONS

MDFT	Minimum Dry Film Thickness
mil	Thousandths of an Inch

1.7 DEFINITIONS

A. MANUFACTURER'S REPRESENTATIVE: Employee of coating manufacturer who is factory trained and knowledgeable in all technical aspects of their products and systems. Sales representatives are not acceptable as a technical representative unless written authorization from the coating manufacture is provided which states the sales representative has full authority to act on the behalf of the coating manufacturer.

B. SPECIALS FITTINGS AND CONNECTIONS: Defined as any joint of pipe with turnout, blowoff, fabricated tee, cross, wye, manhole, mitered angles or elbows, crotch plates, butt straps, or fabricated pipe that cannot be coated using through put or straight pipe coating application equipment and the following specific items:
   1. All pipe joint sections entering a structure.
   2. Pipe joints with weld lead pass through holes.

C. SHOP: A shop is defined as a permanent, fully enclosed building with a concrete floor that can be power washed with a potable water supply and floor drains.

1.8 REFERENCE STANDARDS

A. This specification recognizes AWWA, NACE, and SSPC standards as minimum industry standards and they are referenced for purpose of conformance, except where modified in this section. The requirements of this specification section have been written to a higher design standard with the intent of achieving a long-term coating performance of 100 years.

AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe-4-inch and Larger- Shop Applied.
AWWA C210	Liquid-Epoxy Coating Systems for Steel Water Pipelines.
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipe.
AWWA C215	Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines.
AWWA C216	Heat-shrinkable Cross-linked Polyolefin Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines.
AWWA C217	Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines.
NACE SP0188	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
NACE RP-0274	High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation.
NACE RP0303	Field-Applied Heat-Shrinkable Sleeves for Pipelines: Application, Performance, and Quality Control
NACE SP0394	Application, Performance and Quality Control for Plant Applied Single Layer Fusion-Bonded Epoxy External Pipe Coating.
SSPC-SP-1	Solvent Cleaning Surface Preparation

SSPC-SP-2	Hand Tool Cleaning Surface Preparation
SSPC-SP-3	Power Tool Cleaning Surface Preparation
SSPC-SP-5	White metal Abrasive Blast Surface Preparation
SSPC-SP-6	Commercial Abrasive Blast Surface Preparation
SSPC-SP-10	Near White Metal Abrasive Blast Surface Preparation
SSPC-SP-11	Power Tool Cleaning to Bare Metal

1.9 SPECIAL WARRANTY REQUIREMENTS

A. The Contractor and coating applicator shall warrant to the Owner and guarantee the work under this section against defective workmanship and materials for a period of two (2) years commencing on the date of final acceptance of the work.

1.10 OBSERVATION OF WORK

A. The Contractor shall give the Owner Representative notice a minimum of 14 days prior to start of work for scheduling shop or field observation.

B. Provide Owner Representative a minimum 3 days' notice for actual start of surface preparation and coating application work.

C. Provisions shall be made to allow Owner's representative full access to facilities and appropriate documentation regarding coating application.

D. Observation by the Owner's representative or the waiver of observation of any portion of the work shall not be construed to relieve the Contractor of his responsibility to perform the work in accordance with these Specifications.

E. Materials shall be subject to testing for conformance with this specification as the Owner's representative may elect, prior to or during incorporation into the work.

PART 2 MATERIALS

2.1 GENERAL

A. Coatings and linings will be stored and handled per manufacturer's written directions.

B. Exterior and interior pipe and fitting surfaces shall be prepared and coated in accordance with referenced standards, written instructions of the coating or lining manufacturer, and these specifications, whichever is more stringent.

C. Pipeline coating or lining shall be the product of a single manufacturer. Product substitutions during the project will not be permitted, without Engineer approval.

2.2 SHOP-APPLIED, BURIED PIPE COATINGS

A. General

1. Buried pipe, consisting of straight lengths of pipe, shall be coated with one of the following coating systems at the Contractors option, except where noted otherwise.
    a. Polyethylene Tape Wrap and cement overcoat (AWWA C214 and C205) – ductile iron pipe option only
    b. Plural Component Epoxy (AWWA C210) – steel pipe and ductile iron pipe option
2. Buried Steel or Ductile Iron pipe specials, fittings, and other complex shapes, shall be coated with one of the following coating systems.
    a. Plural Component Epoxy (AWWA C210)
3. Vault or manhole piping and miscellaneous pipeline components, such as coupling plain ends, access manholes, blowoff piping, or piping less than 12-inches in diameter, shall be coated as specified under Shop Applied, Atmospheric and Immersion Coatings, this section.
4. Buried dielectrically coated pipe and fittings passing through a concrete structure wall or floor shall be dielectrically coated for a minimum of four (4) inches beyond the interior wall or floor surface.
5. Exterior surfaces of all butt straps shall be prepared to SP-5, white metal, and coated with inorganic zinc suitable for temperatures over 750 degrees as specified for holdback corrosion protection.

B. Polyethylene Tape Wrap (option for buried ductile iron pipe):
1. General Coating Requirements:
    a. Tape wrap coating system shall be machine applied. Hand applied tape coatings will not be permitted.
    b. Tape width shall be 12-inches maximum. Wider tape will be conditionally allowed if the coating applicator can demonstrate that proper maintenance of tension and prevention of mechanical wrinkling throughout the coating application. If at any time during the pipe fabrication tape quality becomes inconsistent with wider tape, the Engineer can require the remainder of the pipe to be coated using the maximum specified tape width.
    c. Tape layers shall have adhesive for the full width of the tape. Adhesive shall have the ability to stick to itself and to the proceeding tape layer or pipe.
    d. Each layer shall be a different color or shade with the outer layer white.
    e. Outer wrap shall be white and have sufficient ultraviolet (UV) inhibitors to resist above grade exposure for a minimum of 12 months or the proposed storage and construction time, whichever is greater.
2. Ductile Iron Pipe:
    a. Surface Preparation:
        (1) Comply with salt contamination and surface cleanliness (dust) requirements as specified for Quality Control testing.
        (2) White Metal blast, SSPC-SP5, 2.5 mils blast profile, minimum.
    b. Coating System
        (1) Pipe shall be coated with an 80 mil (nominal), tape-coating systems applied in accordance with AWWA C214, except as modified herein.
        (2) Ductile iron pipe with cement mortar overcoat shall be coated with 50 mil (nominal), tape-coating systems applied in accordance with AWWA C214, except as modified herein.Primer: Polyken 1019, 1027, 1029, or as recommended by the coating manufacturer.

(3) Weld Stripe Tape: Polyken 931 (no backing), 25 mils nominal, 4-inches wide minimum.
(4) Inner Wrap: Polyken 989 YGIII, 20 mils nominal, corrosion protection layer.
(5) Outer Wrap: Polyken 956 YGIII, 30 mils nominal, mechanical protection layer.
(6) Mechanical Protection: Cement mortar overcoat in accordance with AWWA C205, except as modified herein.

C. Plural Component Epoxy (for steel pipe or option for buried ductile iron pipe):
1. General:
a. Plural component, epoxy coating system shall be applied in accordance with AWWA C210, and as modified herein.
b. All steel or ductile iron pipe specials, fittings, complex shapes, and other surfaces that are not suitable for machine applied tape wrap coating application and are below finished grade or concrete encased shall be coated with this coating system.
c. Plural component epoxy coating system is not suitable for interior of pipe or where contact with potable water may occur, see Section 09 90 01, PROTECTIVE COATINGS, for applicable protective coating systems.
2. Shop Surface Preparation:
a. Steel pipe:
(1) Comply with salt contamination and surface cleanliness requirements as specified for Quality Control Testing.
(2) SSPC-SP5, White Metal blast, 3.00 mil profile, minimum, or as required by the manufacturer, whichever is greater.
b. Ductile Iron pipe:
(1) Comply with salt contamination and surface cleanliness requirements as specified for Quality Control Testing.
(2) White Metal blast, SSPC-SP5, 3.00 mil profile, minimum, or as required by the manufacturer, whichever is greater.
3. Shop Applied Coating Requirements:
a. Thickness: One coat, 35 mils total dry film thickness, minimum, or as required to meet limits specified for holiday and coating defects, this section.
b. Epoxy coating shall be used to coat concrete embedded pipe penetrations for 6 inches outside of interior and exterior surfaces of concrete walls or floors.
4. Product Acceptance:
a. Self-priming, plural component, 100 percent solids, non-extended epoxy, suitable for burial or immersion, and meeting the requirements of AWWA C210 and the following, whichever is more stringent:
1) Resistance to Water Immersion (ASTM D870) or Wet Adhesion
a) Acceptance criteria:
(1) Not greater than 10 percent loss of substrate adhesion when compared to substrate adhesion in an unexposed area of the same sample with adhesion tests completed within 12 to 24 hours after test termination. Average of three pulls per exposure area.
(2) No blistering or underfilm corrosion when viewed at 10x magnification.

b) Adhesion Testing:
(1) Method: ASTM D4541, Method E
(2) Equipment:Type V, Delfesko Automatic AT Positest
(3) Dollies: 20 mm and 14 mm, scored to metal substrate
(4) Test Speed:100 psi per second (both 14 and 20 mm)
c) Test Duration:30 and 60 days
2) Cathodic Disbondment (ASTM G95)
a) Acceptance criteria: 8 mm, maximum
b) Potential: -3.00 volts
c) Test Duration: 28 days
d) Evaluation: Measured from original holiday radius to edge of staining on metal surface.
3) Water Absorption (ASTM D570)
a) Acceptance Criteria: 1.80 percent, maximum
b) Test Duration:30 day and 60 day
b. Shall be one of the following products:
(1) Tnemec Series 431, Kansas City, MO
(2) Or Engineer approved equal

D. Cement Mortar Coating or Cement Mortar Overcoat Steel Pipe:
1. Apply cement mortar coating system on steel pipe, where specifically shown on the Drawings, in accordance with AWWA C205, except as modified herein. All of the steel pipe on this project are either being backfilled with flowable fill (CLSM) or encased in structural concrete, so no cement mortar coatings anticipated.

2.3 SHOP-APPLIED INTERIOR LININGS

A. General
1. Clean and cement mortar line steel pipe and fittings 6-inches or greater in diameter in accordance with AWWA C205.
2. Cement mortar line ductile iron pipe and fittings in accordance with C104, provide double thickness lining. Do not seal coat the cement lining.
3. Apply liquid epoxy coating over cement mortar lining at insulating joints as specified this section.
4. Epoxy line pipe 36-inches diameter or smaller per System No. 1 or fusion bonded epoxy lining at contractor's option. Fusion bonded epoxy lining shall be NSF certified.

B. Cement Mortar Lining:
1. Cement: Conform to ASTM C150, Type II.
2. Shop applied cement mortar lining shall be uniform in thickness over the full length of the pipe joint.
3. Aggregate shall be silica sand or other aggregate that is not subject to leaching. Conform to ASTM C33.
4. Water for cement mortar: Clean and free from organic matter, strong alkalis, vegetable matter, and other impurities.

C. Liquid Applied Epoxy Coating:

1. Epoxy Overcoat of Cement Mortar Lining:
    a. Provide liquid epoxy primer and lining in all cement mortar lined metallic pipe at insulating joints for a minimum of one pipe diameters on each side of the insulated joint. If other side of joint is an existing pipe, apply epoxy lining for two pipe diameters in fabricated pipe only.
    b. Epoxy lining shall be polyamine or polyamide cured, NSF approved for potable water contact in accordance with ANSI/NSF Standards 60 and 61, and capable of achieving full cure before placement in service or exposure to water.
    c. Application:
        (1) Apply in two coats at equivalent spread rate for 6 mils dry film thickness per coat.
        (2) Epoxy shall be applied over the cement mortar lining where specified for the pipeline lining material.
        (3) Cement mortar shall be allowed to cure for a minimum of 15 days prior to surface preparation and coating application or 7 days with steam curing. Mortar lining shall be dry when epoxy lining is applied.
        (4) Prepare the cement mortar lining by abrasive blasting to remove all laitance and provide a surface profile equivalent to 80 grit sandpaper.
    d. Acceptable manufacturers:
        (1) Carboline
        (2) ICI Devoe
        (3) Tnemec
        (4) Sherwin Williams
        (5) Or approved equal

2.4 SHOP APPLIED, ATMOSPHERIC OR IMMERSION COATINGS

A. General
1. All atmospherically exposed or vault piping shall be shop primed and field coated with the applicable Exposed Metal coating system as specified in Section 09 90 01, Protective Coatings.
2. Interior of pipe or surfaces in contact with potable water shall be coated with System No. 1.
3. Shop applied inorganic zinc primer shall not be applied at thickness greater than recommended by manufacturer. Excess primer to be removed using method recommended by coating manufacturer.
4. Intermediate and finish coats shall be applied in the field after installation, except where metal surfaces will be concealed after installation.
5. All concealed surfaces of bolted or mechanically secured surfaces shall be finished coated in the shop.
6. Manufacturer of shop-applied primer shall be coordinated with field application to provide a completed system by a single manufacturer. Engineer approval of a coating system with two or more coating manufacturers' will require written approval from all coating manufacturers as to compatibility and acceptance under warranty.

2.5 FIELD APPLIED COATING SYSTEMS

A. General
   1. Miscellaneous Metals
      a. All buried miscellaneous metal components installed on the pipeline and that is supplied bare or with a shop coating system that is not equal to the specified pipeline coating shall be coated in the field with one of the following coating systems.
         (1) Petrolatum or Wax Tape Coating
         (2) Heat Shrink Sleeve
      b. Miscellaneous metal components shall include, but not be limited too, all exposed metals surfaces, including bolts, couplings, flanges, valves, adapters, pipe spools, and other miscellaneous metal components.
      c. Coating system applied shall conform to the manufacturer's requirements and shall be applied in accordance with the application requirements of the coating system.
      d. Filler material shall be applied for all field applied coating systems to provide sufficient transition at welds and other dimensional changes to prevent all tenting or voids under the applied coating, regardless of manufacturer's recommendations.

   2. Pipe Joints General:
      a. Pipe joints shall be field coated after pipe assembly with one of the following coating systems as specified.
         (1) Petrolatum or wax tape coating system
         (2) Heat Shrink Sleeves.
      b. Pipe joints shall be coated with a heat shrink coating, unless specified otherwise. Provide filler mastic to prevent tenting or voids under the sleeve.
      c. Flanges, couplings, and all bolted or threaded joints are classified as complex shapes and shall be wax tape coated with filler material to ensure completed encapsulation and filling of all bolts, crevices, gaps, and dimensional transitions as required to prevent tenting of the finished coating.

B. Petroleum or Wax Tape Coating:
   1. Application:
      a. Coating shall be applied in accordance with AWWA C217, except as modified herein.
      b. Wax tape coatings shall be field applied on all buried couplings, thrust restraint rods and brackets, valves, and on joints, fittings, or irregular shapes or complex configurations that could cause tenting of heat shrink coating system.
      c. Provide wax filler material for all complex shapes, bolts, flanges, gaps, and dimensional transitions to completely fill and encapsulate the metal surfaces and prevent tenting of the applied tape coating.
      d. Buried wax tape coated surfaces shall be overcoated with plastic shrink film as recommended by the manufacturer.
      e. Do not use wax tape coating systems on vault piping, atmospherically exposed piping and appurtenances, or where subject to UV exposures.
      f. Use sand backfill to protect wax coating from damage.

2. Surface Preparation: SP11 Power Tool to Bare Metal or SSPC-SP10, near white abrasive blast.
3. Coating System:
    a. Primer: petroleum or petrolatum wax, suitable for wet surfaces.
    b. Filler Material:
        (1) Filler materials shall be petroleum or petrolatum wax sealer/filler with closed cell plastic filler
        (2) Provide filler material to fill and smooth all irregular surfaces, such that no tenting or voids remain under the applied wax tape.
    c. Inner Tape: Petroleum or petrolatum wax impregnated fabric, 6-inch width maximum, 40 mils thick
    d. Outer Wrap: PVC or tape suitable for application to inner tape.
4. Manufacturers: Wax tape coating system shall be as manufactured by:
    a. Denso North American
    b. Trenton
    c. Or approved equal.

C. Heat Shrink Sleeves:
1. Application:
    a. Heat shrink sleeves are restricted to pipeline joints and couplings under buried or concrete encased applications only.
    b. Application inside vaults or where exposed to the weather will not be allowed.
    c. Provide filler material for all welded joints, rolled or Carnegie joints, and at all dimensional changes that could result in tenting or voids under the applied heat shrink sleeve.
    d. Pipe joints that have been shop prepared as specified for heat shrink sleeves and shop coated with holdback primer as specified this section, shall be field prepared in accordance with SSPC-SP1, solvent cleaning, and SP3, Power tool cleaning, to remove all dirt, mud, oil, and grease prior to application of heat shrink sleeve.
    e. Filler material shall be applied in a manner and of sufficient thickness that no tenting or voids remain under the heat shrink sleeve.
    f. Contractor to consider sleeve shrinkage and joint profile in determining sleeve width required. Overlapping of two or more heat shrink sleeves to achieve the necessary width on pipe joints will not be permitted without Engineer approval.
2. Surface preparation: As specified for pipe joint surface preparation.
3. Coating System:
    a. Filler Material:
        (1) Filler material shall adhere to the pipe and heat shrink sleeve. Size and type shall be as recommended by the sleeve manufacturer for type of pipe and joint.
        (2) Filler materials shall be applied as necessary to prevent all tenting or voids under the applied heat shrink sleeve, regardless of manufacturer's written recommendations.
        (3) Filler mastic for joints subject to weld after backfill shall have a melt temperature exceeding 500 degrees F.
    b. Heat Shrink Sleeve:

(1) Heat shrink, cross-linked polyolefin sleeve with a mastic sealant, 85-mil nominal thickness or greater, suitable for pipeline operating temperature, as recommended by the manufacturer.
(2) Provide standard recovery sleeve for welded or bell and spigot steel pipe joints. High recovery sleeves shall be provided for mechanical or bell and spigot ductile iron pipe, flange joints, and coupling style joints.
(3) Width of heat shrink sleeves shall be sufficient to overlap existing coating 2-inches minimum, except extruded polyolefin coated pipe shall have a minimum overlap of 3-inches. Overlap on tape coated steel pipe shall be based on a sequential 2-inch wide step from outer wrap to middle wrap to inner wrap.
(4) Sleeve shall meet requirements for "Well After Backfill" when procedure is allowed and approved by Engineer.

4. Coating Manufacturer's:
   a. Canusa,
   b. Raychem-Covalence,
   c. Or equal.

D. Epoxy Coating:
1. Application:
   a. Epoxy coatings shall be NSF approved and suitable for water contact in accordance with ANSI/NSF Standards 60 and 61, unless otherwise approved by the Engineer.
   b. Contractor shall ensure that epoxy coating selected is suitable for the application temperatures anticipated and that project schedule will allow adequate cure time before backfilling or immersion based on surface temperatures at the time of application.
   c. Epoxy coating shall be used to coat concrete embedded pipe penetrations for 6 inches outside of interior and exterior surfaces of concrete walls or floors. Epoxy coating at concrete penetrations shall be a minimum of 16 mils dry film thickness.
   d. Buried transitions from epoxy to tape wrap coating systems shall be coated with Heat Shrink Sleeve as specified below. Heat shrink sleeves shall be buried within 72-hours of application to prevent thermal creep of sleeve. Sleeves subject wrinkling due to thermal exposure shall be removed and replaced by the Contractor.
2. Surface Preparation: SP11 Power Tool to Bare Metal or SSPC-SP10, near white abrasive blast.
3. Coating System:
   a. Primer: As required by the coating manufacturer.
   b. High Build Epoxy Coating:
      (1) Two component, high build polyamide or polyamine cured epoxy coating, suitable for direct burial or immersion, dries to touch in 2 or more hours, suitable for immersion or burial after full cure of coating.
      (2) Acceptable manufacturers:
         (a) ICI Devoe
         (b) Sherwin Williams
         (c) Carboline
         (d) Or approved equal

c. Fast Cure Epoxy Coating:
(1) Two components, 100% solids by volume, fast cure epoxy coating suitable for direct burial or immersion, dry to touch in less than 1 hour at 72 degrees, capable of curing while immersed or buried.

4. Manufacturers:
a. TC 7010, Tapecoat Inc
b. Protal 7125 or Protal 7200, North American Denso
c. Or approved equal.

E. Cement Mortar Coating or Overcoat (NOT USED):

2.6 FIELD APPLIED INTERIOR JOINT LINING

A. Epoxy Lining:
1. Surface preparation and field lining of pipe joints shall be with the same coating system as the shop-applied lining.
2. Field application shall be performed by a qualified contractor with equipment that meets the application requirements of the coating system and personnel trained and certified by the coating system manufacturer on the proper application of the coating system. Qualified field applicator shall have completed at least three other projects of similar size and magnitude within the last three years using the same or similar coating system.
3. Coating applicator that does not meet the qualifications requirements can be rejected by the Engineer.
4. Field coating application requirements shall be the same as the shop-applied coating requirements. Provide heating and/or dehumidification equipment as required to meet the environmental conditions necessary for proper coating application.

B. Mortar Lining:
1. After the backfill has been completed to final grade, the interior joint recess shall be filled with grout. The grout shall be tightly packed into the joint recess and trowelled flush with the interior surface. Excess shall be removed.
2. At no point shall there be an indentation or projection of the mortar exceeding 1/16-inch.
3. With pipe smaller than 24-inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with grout. The joint shall be completed and excess mortar on the inside of the joint shall be swabbed out.

2.7 REPAIR OF COATINGS AND LININGS

A. General
1. Coating or lining repair materials shall be compatible with the shop-applied coating or lining system and shall be approved by the coating or lining manufacturer.
2. Coating repair materials shall be as required for the coating system and repair classification as defined this section.

B. Coating Repair Materials

1. Heat Shrink Sleeves (major repair):
    a. Filler Mastic: Provide mastic filler to fill tape void as required.
    b. Shrink Sleeve: See Field Applied Coatings, Heat Shrink Sleeves, this section.

2. Heat-Applied Patches (minor repair)
    a. Heat applied adhesive, polyolefin backed, mastic coated tape, 12-inches maximum size.
    b. Patch shall provide a minimum of 2 inches overlap onto intact pipe coating; except for extruded polyolefin coated pipe shall have a minimum overlap of 3-inches in the circumferential direction.
    c. CRP patch as manufactured by Canusa, PERP patch as manufactured by Raychem (Polyken), or equal.

3. Plural Component Epoxy Coating or Lining
    a. Major Repairs:
        (1) Shop repairs shall be completed using the same material as the pipe coating. Coating shall be reapplied using plural component spray equipment in accordance with manufacturer's written requirements.
        (2) Field repairs shall be completed using heat shrink sleeves as specified for field applied coatings, this section.
        (3) Shop or field major repairs to NSF linings shall be with single use kits matching the existing lining.
    b. Minor Repairs:
        (1) Shop minor repairs shall be single use kits matching the existing coating. Pinholes, holidays, or adhesion test repairs are classified as minor repairs.
        (2) Field minor repairs shall be with fast cure epoxy, such as Protal 7125 as manufactured by North American Denso, Inc.
        (3) Shop or field minor repairs to NSF linings shall be with single use kits matching the existing lining.

2.8 HOLDBACK CORROSION PROTECTION

A. Primer for corrosion protection of cutbacks or holdbacks shall be compatible with the specified joint coating system and high heat resistant or weld after backfill requirements, where applicable.

B. Approved holdback primers are:
    1. Tnemec Omnithane – Suitable for all joints, except joints subject to high heat resistant or weld after backfill
    2. Tnemec 90E-92 Ethyl Silicate Inorganic Zinc Primer – suitable for all joints, including high heat resistant or weld after backfill joints.
    3. ICI Devoe Cathacoat 304V Ethyl Silicate Inorganic Zinc Primer – suitable for all joints including high heat resistant or weld after backfill joints.
    4. Polyken Tape Primers – Not allowed

C. Primer shall not result in running or melting of the coating or cause toxic fumes when heated during welding of "weld after backfill" joints.

D. Application and thickness of holding primer shall be in accordance with the coating manufacturer's recommendations, but shall not impair the clearances required for proper joint installation.

E. Holdback requirements shall be as specified this section.

PART 3 EXECUTION

3.1 ENVIRONMENTAL LIMITATIONS

A. General
1. Products shall comply with federal, state, and local requirements limiting the emission of volatile organic compounds and worker exposure.
2. Comply with applicable federal, state, and local, air pollution and environmental control regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, and coating application.
3. Do not perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent, whenever surface temperature is less than 5 degrees above the dew point of the ambient air.
4. Do not apply coatings when:
   a. Surface and ambient temperatures exceed the maximum or minimum temperatures recommended by the coating manufacturer or these specifications,
   b. In dust or smoke-laden atmosphere, blowing dust or debris, damp or humid weather, or under conditions that could cause icing on the metal surface.
   c. When it expected that surface temperatures would drop below 5 degrees above dew point within 4 hours after application of coating.
   d. Whenever relative humidity exceeds 85 percent.
5. Where weather conditions or project requirements dictate, Contractor shall provide and operate heaters and/or dehumidification equipment to allow pipe surfaces to be abrasive blasted and coated as specified and in accordance with the manufacturers coating application recommendations.
6. Work activities can be restricted by the Engineer until adequate temperature and humidity controls are in place and functioning within the environmental limits specified.
7. Coating applicator shall provide a monitoring system approved by the coating manufacturer that constantly records pipe and coating conditions during coating application. Recorded monitoring parameters shall include pipe temperature, line speed, holiday test and other parameters applicable to the type of coating.

B. Temperature Control
1. In cold weather or if moisture collects on the pipe, preheat pipe to a temperature between 45 and 90 degrees or 5 degrees above dew point, whichever is greater.
2. When temperatures are above or below the coating manufacturers recommended application temperatures, the Contractor will provide temperature controls as necessary to permit work to precede within the manufacturer's temperature limitations.

3. Provide tenting, insulating blankets, baffles, or bulkheads as required to zone and control heating or cooling effectiveness.
4. Heating shall be with indirect fired heaters that do not increase humidity levels within the work area. Heaters shall be sized for the area to be heated.

C. Dehumidification
1. Contractor shall provide and operate desiccant dehumidification equipment to maintain environmental conditions during abrasive blasting and coating application and cure. Liquid, granular, or loose lithium chloride drying systems will not be acceptable.
2. Contractor shall provide dehumidification equipment sized to maintain dew point temperature 17 degrees or more below surface temperature of metal surfaces to be cleaned and coated. System shall provide ventilation within the environmentally controlled areas to meet the following requirements:
   a. Two air exchanges per hour, minimum,
   b. Maintenance of personnel exposure limits (PEL) at 50 percent of OSHA PEL limits for all chemicals used in the performance of the work, and
   c. Maintenance of lower explosive limits (LEL) to less than 50 percent of the most volatile solvent used in the performance of the work.
3. Dehumidification equipment type, size, air flow, and power requirements shall be designed by a qualified company knowledgeable in dehumidification equipment, and its operation based on project requirements and anticipated seasonal weather conditions for the project schedule. Design to include evaluation of existing conditions, humidity, and temperature, proper air exchange requirements, ventilation requirements, ducting requirements for adequate air flow, and any other issues necessary to achieve the specified performance and environmental conditions throughout the duration of the project.
4. Contractor to submit written recommendations from dehumidification subcontractor for enclosure work area size, bulkhead venting, duct work for each bulkhead section, any secondary ventilation requirements for coating cure, dust collection equipment CFM requirements, and drying requirements for blast hose compressed air necessary to maintain environmental control as specified herein.
5. Dehumidification subcontractor shall either operate the equipment or provide training to Contractor on the proper operation and setup of dehumidification equipment. Dehumidification subcontractor shall provide a technical representative on site for a minimum of two 8 hour days to insure proper operation of the equipment, achievement of desired environmental control, and to insure Contractor can properly setup, operate, monitor, and maintain the equipment.
6. Dehumidification shall be operated in a manner that prevents all condensation or icing throughout surface preparation, coating application, and coating cure.
7. Reblasting of flash rusted metal surfaces or removal of damaged coatings, because of equipment malfunction, shutdown, or other events that result in the loss of environmental control, will be at the sole expense of the Contractor. Cleaned metal surfaces subject to flash rusting shall be cleaned to the same cleanliness as prior to the flash rust formation and shall be approved by the Engineer.
8. Contractor shall monitor ambient temperature, humidity, dew point temperature, and pipe surface temperature (work area only) both outdoors and within the

work area at the start, midpoint, and end of each work shift, minimum, but not greater than 5 hours between measurements.

9. Daily environmental condition monitoring and maintenance of the equipment shall be documented in writing and posted near the equipment for review by the Engineer.

3.2 SURFACE PREPARATION

A. General

1. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of coating manufacturer whose product is to be applied.
2. Visible oil, grease, dirt, and contamination shall be removed in accordance with SSPC-SP1, solvent cleaning.
3. Surface imperfections such as metal slivers, burrs, weld splatter, gouges, or delaminations in the metal shall be removed by filing or grinding prior to abrasive surface preparation.
4. Protect prepared pipe from humidity, moisture, and rain. All flash rust, imperfections, or contamination on cleaned pipe surface shall be removed by blasting.
5. Priming and coating of pipe shall be completed the same day as surface preparation.

B. Weld Surface Preparation

1. Requirements:
   a. Spray applied coating systems do not require weld grinding.
   b. Grind welds flush on extruded polyolefin coated pipe as specified herein.
   c. Welds on tape wrap coated pipe shall be either ground flush or a weld stripe tape applied over the weld, at the pipe fabricator's option, unless otherwise specified.
2. Weld Grinding:
   a. Under the weld grinding option, welds higher than 1/32 inch above pipe surface shall be ground to a tolerance of +1/32 inch to 0-inch above the pipe surface as measured on the lowest side of the weld.
3. Weld Stripe Tape:
   a. Weld stripe tape will be applied to primed metal.
   b. Tape will either have no polyethylene backing or will be double sided adhesive tape to permit adhesion of the inner corrosion protection layer to the weld stripe tape.
   c. Apply tape with a pressure roller to fully conform the tape to the weld surface.
   d. Adhesion of the weld stripe tape shall be as specified for the coating system.

C. Salt Contamination Removal

1. All bare or shop coated or primed surfaces that will be coated in the field shall be pressure washed with potable water not greater than 8 hours before coating application, including pipeline joints.
2. Residual soluble salt contamination (SSC) shall be tested as specified under Quality Control testing.

3. Surfaces to be Abrasive Blasted:
    a. Surfaces that fail the soluble salt contamination test prior to abrasive blasting shall be cleaned by pressure washing and/or abrasive blasting and retested.
    b. Surfaces that fail the SSC test after surface preparation shall be recleaned and/or abrasive blasting and retested.
    c. Surfaces which still exceed the specified SSC level after recleaning shall be subject to determination by the Engineer if addition work will be required.
    d. Contractor shall remove all surface rust caused by SSC testing in accordance with SP-11, Power Tool to Bare Metal or abrasive blasting to the specified cleanliness.
4. Existing or Shop Primed Surfaces:
    a. All previously coated surfaces shall be tested for SCC prior to application of additional coats.
    b. Surfaces exceeding the specified SSC level after pressure washing shall be subject to additional cleaning as determined by the Engineer.
    c. Any coating applied before SCC testing is completed and accepted by the Engineer will be rejected and removed.

D. Steel Surface Preparation
1. Surface preparation of steel pipe shall be in accordance with SSPC surface preparation standards utilizing the degree of cleanliness specified for the coating system to be applied or as specified herein, whichever is more stringent.
2. Grit and/or shot abrasive mixture and gradation shall be as required to achieve the degree of cleanliness and coating adhesion specified.
3. Pipe cleaned by abrasive blasting with recyclable steel grit and/or shot or other abrasive shall be cleaned of debris and spent abrasive in an air wash separator.
4. Epoxy coated steel shall have a sharp angular surface profile of the minimum depth specified.
5. After abrasive blasting surfaces and before coating application, the metal surface shall be cleaned of residual dust to a minimum of Grade 2 per ISO Standard 8502-3, Test for the Assessment of Surface Cleanliness.
6. Work shall be performed in a manner that does not permit the cleaned metal surface to rust back or flash rust.
7. Rust back or flash rust shall be fully removed with the steel surface cleanliness equal to the metal surface cleanliness prior to rust back or flash rusting. Determination of the equivalent surface cleanliness shall be at the Engineer's sole discretion.

E. Concrete Surface Preparation:
1. Cement Mortar or Concrete Cure:
    a. Cement mortar linings shall be allowed to cure for a minimum of 15 days prior to surface preparation and coating application or 7 days with steam curing.
    b. Concrete surfaces shall be cured 30 days.
2. Preparation Requirements:
    a. Remove grease, oil, dirt, salts or other chemicals, loose materials or other foreign matter by solvent, detergent, or other suitable cleaning methods.

b. Clean concrete using mechanical or chemical methods for the degree of cleaning specified for the coating system in accordance with SSPC SP-13, Surface preparation of Concrete.
c. Abrasive blast to remove all laitance and provide a surface profile equivalent to 80 grit sandpaper.
d. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to coating.

3. Inspection:
   (1) Concrete Soundness: Determined using scratching or hammer impact methods as defined in SSPC SP-13.
   (2) Moisture Content: Moisture shall be tested as Specified in SSPC SP-13 and shall not exceed the moisture content recommended by the coating manufacturer.

3.3 SHOP -APPLIED COATING APPLICATION

A. Tape Wrap Coating
1. Applicator shall provide a monitoring system approved by the tape manufacturer that constantly records pipe and tape conditions during coating application. Recorded monitoring parameters shall include, but not be limited too, pipe temperature; line speed, primer and tape roll body temperature, and tape tension.
2. Pipe surface temperature shall be between 45 and 120 degrees and 5 degrees above dew point, whichever is greater.
3. Tape roll temperature shall be in accordance with the manufacturer's recommendations, but shall not be less than 55 degrees for the inner wrap and 65 degrees for the outer wraps.
4. Apply a uniform coat of primer as recommended by the manufacturer without skips, runs, or sags. Allow to properly dry prior to applying the tape as required by the tape manufacturer and as necessary to achieve maximum tape adhesion. Rug type application will not be allowed.
5. If welds are not ground flush, apply a weld stripe tape to longitudinal or spiral pipe welds prior to application of the inner wrap.
6. Tape layers shall be applied continuously with the use of hydro-tension tape stands. Tension shall be maintained between the manufacturer's minimum and maximum tension recommendations or as required to achieve approximately 2.0 percent reduction in tape width.
7. Inner tape wrap shall adhere tightly to the pipe surface. Coating shall be 100 percent adhering to the metal surface and shall not have any visible damage, wrinkles, voids, disbondment, contamination, or holidays.
8. Tape coating adhesion testing shall be performed on the pipe as specified this section.
9. Holidays testing shall be conducted on the inner layer tape prior to proceeding with subsequent tape layers. All holidays detected shall be primed and patch using coating repair procedures specified herein.
10. Perform coating and lining repairs as specified in this section.

B. Plural Component Epoxy Coating
1. Applicator Qualifications:

a. Equipment will be certified by the coating manufacturer to meet the requirements for material mixing, temperature control, application rate, and ratio control for multi-part coatings.
b. Equipment not meeting the written requirements of the coating manufacturer shall be rejected for coating application until repairs or replacement of the equipment is made to the satisfaction of the Engineer.
c. Personnel responsible for the application of the coating system shall have certification of attendance at the coating manufacturer's training class within the last three years. The certified applicator shall be present during all coating application work and shall have responsibility for controlling all aspects of the coating application.

2. Pipe surface temperature shall be between 50 and 100 degrees or 5 degrees above dew point, whichever is greater.
3. Coating application shall be performed in an environmentally controlled shop area that meets or exceeds the written environmental application requirements of the coating manufacturer. Application in outdoor conditions will not be acceptable without adequate environmental shelter, environmental controls, and/or dehumidification.
4. Coating adhesion and holidays testing shall be tested as specified this section except adhesion testing is not required on overcoated CCP.
5. Coating manufacturer shall provide to the Engineer a copy of the manufacturer's coating application quality assurance manual prior to beginning coating application. Strict conformance to the requirements of the manual will be required. Deviation from the requirements of the manual will be grounds for the Engineer to reject the applied coating.
6. Unacceptable Coating Application
   a. Coating applied under improper environmental conditions will be rejected.
   b. Pipes that exceed the allowable quantity of coating defects, regardless of size or cause, shall be rejected.
   c. Coating which fails the adhesion or holiday testing as specified this section shall be rejected.
   d. Pipe coating that is subject to off ratio application, blistering, or is not applied in conformance with the coating manufacturer's written instructions or recommendations shall be rejected.
7. Rejected coating shall be removed from the full length of the pipe to bare metal and reapplied using proper application methods in accordance with the coating manufacturer's written instruction and the requirements of these specifications.
8. Perform coating and lining repairs as specified in this section.

C. Cement Mortar Coatings (NOT USED)

3.4 SHOP-APPLIED LINING APPLICATION

A. Shop-applied Cement Mortar Lining:
1. Place mortar lining used in steel piping and steel plate specials in pipe to thickness below.

Pipe Diameter,	Lining Thickness,	Tolerances,

Inches	Inches	Inches
4 through 10	3/8	-1/16, +1/8
11 through 24	5/16	-1/16, +1/8
24 through 36	3/8	-1/16, +1/8
Greater than 36	1/2	-1/16, +3/16

2. Centrifugally line straight sections of pipe. Lining of special pieces or fittings shall be by mechanical, pneumatic, or hand placement. Provide cement mortar lining of uniform thickness. Finish to a smooth dense surface.
   a. Steel plate specials larger than 16 inches in diameter shall have lining reinforced with 2-inch by 4-inch No. 13-gage welded steel wire mesh.
   b. Brace and support pipe during lining application to minimize pipe distortion or vibration. Bracing and supports shall not damage the pipe, coating, or lining.
   c. Tightly close ends of pipe and fittings with plastic sheet caps. Plastic end caps shall be of sufficient thickness and strength to resist shipping, handling, and storage stresses.
   d. Damage to the cement mortar lining, including disbondment, cracking, or blistering, caused by improper curing, shipping, handling, or installation shall be repaired in accordance with AWWA specifications and to the satisfaction of the Engineer.
3. Other requirements of mortar lining materials and processes: As specified in AWWA C205.

B. Liquid Epoxy Lining:
   1. Pipe Lining, Direct to Metal
      a. Where epoxy lining on steel pipe is specified or shown on drawings or where the pipe is not cement mortar lined, an epoxy lining shall be applied directly to the steel surface as specified in Section 09 90 01, Protective Coatings.
      b. Immersion System specified in Section 09 90 01, shall be modified to three coats, minimum, at a total coating thickness of 20 mils dry film thickness.
   2. Pipe Lining, Insulating Joints:
      a. Coating applied over cement mortar lining shall be applied in a manner that will minimize gassing and pinholes in the completed lining.
      b. Clean and coat the interior of cement mortar lined pipe at insulating joints with two coats of epoxy coating.
      c. Epoxy coating applied at insulating joints shall be applied to both sides of the insulating joint for a minimum of one pipe diameter. If only one side of the joint can be coated the coating shall be applied for a minimum of two pipe diameters.
      d. Mortar lining shall be allowed to cure 15 days or steam cured not less than 7 days prior to surface preparation of the mortar and epoxy coating application. Hand applied mortar lining shall be allowed to cure a minimum of 15 days or as required to meet the coating manufacturer's requirements for application on cement or concrete, whichever is greater.

e. Prepared mortar lining by abrasive blasting to remove all laitance and create a suitable anchor profile
f. Mortar lining shall be dry during epoxy lining application.

3.5 COATING AND LINING HOLDBACK

A. All coating and lining holdback areas shall be prepared as specified for the pipeline coating and protected from corrosion during storage and installation with a specified holdback coating system.

B. Internal holdback for cement mortar lined pipe shall be left unprepared and unprimed.

C. Internal holdbacks for dielectrically lined pipe shall be left bare and prepared and lined in the field as specified for field lining of joints after joint assembly.

D. External holdbacks shall be as listed below with all dimensions based on end of bell or spigot. Pipe manufacturer may adjust holdback limits as required for special joint assemblies, and with consideration for the joint coating provided and joint welding requirements. All dimensions from end of pipe.

Tape wrap coating	
Push-on joint, spigot	1-inch, minimum after centerline of gasket.
Push-on, bell	Flush with bell end
Welded, spigot	1 inches, minimum
Welded, Bell	Stab Depth + 2-inches, minimum
Epoxy coating	
Push-on joint, spigot	1-inch after centerline of gasket
Push-on, bell	Flush with bell end
Welded, spigot	3 inches, minimum
Welded, Bell	Stab Depth + 2-inches, minimum

E. Coating holdbacks shall be straight and cut through the full thickness of the coating.

F. Cutbacks shall be completed in a manner that permits field coating of joints in accordance with the manufacturer's recommendations and as specified herein.

3.6 FIELD COATING JOINTS

A. General:
   1. Joint bonds shall be installed before application of joint coating as specified in Section 13 47 13 Cathodic Protection.
   2. Joint bonds shall be low profile bonds and all gaps and crevices around the bonds shall be filled with filler mastic.
   3. Filler mastic shall be placed under copper strap bonds and extended ½ inch minimum beyond edges of bond to allow for sealing with heat shrink sleeve.
   4. Contractor to electrically test completed joint coating for holidays with high voltage spark tester at Engineer's direction or if damage to the joint coating occurs.

B. Field Surface Preparation:
   1. Pipe joints with hold back corrosion protection:
      a. Perform salt contamination removal as specified under Surface Preparation.
      b. Field prepare joint in accordance with SSPC-SP1, solvent cleaning, and SP3, Power tool cleaning, to remove all dirt, mud, oil, and grease prior to application of heat shrink sleeve.
      c. Any visible rusting areas shall be spot prepared in accordance with SP-11, power tool to bare metal.
   2. Pipe joints without hold back corrosion protection:
      a. Perform salt contamination removal as specified under Surface Preparation.
      b. Abrasively blast joint in field in accordance with SSPC-SP5, white metal blast.
      c. Sweep blast epoxy coating for 2-inches for 80-grit sandpaper equivalent profile for coating adhesion.
   3. All loose or damage coating shall be removed and repaired per specified coating repair procedures.

C. Weld After Backfill' Joint Requirements:
   1. Post-welded or 'Weld after Backfill' joints are defined as welded pipe joints that have been coated and backfilled prior to completing interior welds.
   2. Post welded joints shall be coated and protected as follows:
      a. Joint coating shall be heat shrink joint sleeves only with a minimum coating thickness over the weld heat affected zone of not less than 120 mils before welding. Tape wrapped joints or heat resistant tape will not be acceptable.
      b. Manufacturer's recommendations for heat shrink sleeves selection and application and this specification shall govern WAB joints. If a conflict occurs, the more stringent requirement shall apply.
      c. Hold back primer shall be suitable for post weld conditions as specified this section and shall not exhibit any binder breakdown in the heat affected zone that causes loss of joint coating adhesion to the holdback primer.
      d. Filler mastic materials shall be high temperature material with 500 degree F melting point.
      e. Joints shall be fully buried prior to welding, with not less than 12-inch soil cover or flowable fill material on all sides. Sand or flowable fill backfill is preferred for weld after backfill joints. Crush rock or angular gravel backfill can be detrimental to the heat shrink sleeve when using WAB procedures.

f. Heat shrink sleeves after WAB shall exhibit no holidays, burn through of coating, creasing, carbonization of the sleeve adhesive, or disbondment of the sleeve or holdback primer.

3. Welding of the joints shall be in conformance with Section 33 11 11, Steel Pipe, and as modified herein:
   a. All welding shall be with two or more weld passes as required to meet the specified AWS qualified welding procedures and maximum coating temperature limitations. 'Weld after Backfill' procedures on wall thicknesses of ¼ inch or less must be approved by the Engineer based on field testing demonstrating the welding procedures can comply with the requirements of this specification.
   b. Welding speed, amperage, and voltage shall be as required to maintain a maximum heat input of 23,000 joules or a maximum surface temperature at the coating/steel interface of 750 degrees F, whichever is least.
   c. Maximum weld temperature and duration shall not result in carbonization of the joint coating adhesive. Carbonization is defined as the loss of volatile organic compounds that result in loss of tackiness, adhesion to the steel, and corrosion protection properties.
   d. Finished joint coating shall not have any visual creases or folds in the joint coating backing material that extends through both the inner protective layer and outer joint sleeve.
4. If Contractor elects to post-weld any joints, Contractor shall demonstrate that the joint welding procedures will not significantly damage the coating by fully excavating the first two joints for evaluation of the joint coating condition. Engineer will randomly select up to three additional post-welded joints for excavation by Contractor for evaluation of joint coating condition. Joint coating will be destructively evaluated by the Engineer. Contractor will remove and replace joint heat shrink sleeve upon completion of the evaluation.
5. If any excavated post welded joint exhibits any heat related damage as defined herein, Contractor shall modify and test a new post welding procedure prior to completing any additional post-welded joints. Contractor shall demonstrate that the revised joint welding procedure will not significantly damage the coating by repeating the weld after backfill evaluation requirements defined this Section, including excavation of the three additional randomly selected joints for destructive evaluation.

D. Heat Shrink Sleeve Joint Coating:
1. Store, handle, and apply field heat shrink sleeve coatings in accordance with AWWA C216 and these specifications.
2. Store sleeves in shipping box until use is required. Keep dry and sheltered from exposure to direct sunlight. Store off the ground or concrete floors and maintain at a temperature between 60 and 100 degrees as recommended by the sleeve manufacturer.
3. Joint shall be prepared as specified in Pipe Joint Surface Preparation.
4. Preheat pipe uniformly as recommended by the sleeve manufacturer. Monitor pipe temperature using a surface temperature gauge, infrared thermometer, or color changing crayons. Protect preheated pipe from rain, snow, frost, or moisture with tenting or shields and do not permit the joint to cool.
5. Apply filler material as specified in Field Applied Coating Systems.

6. Apply heat shrink sleeve when sleeve has a minimum temperature of 60 degrees and while maintaining the pipe temperature above the preheat temperature specified. Apply sleeve in accordance with the manufacturer's instructions and center the sleeve over the joint to provide a minimum 2-inch overlap onto the existing pipe coating.
7. Acceptable joint sleeve installations shall meet the following requirements:
    a. Shall be fully bonded to the pipe and existing coating surface without tenting or voids.
    b. Mastic beading shall be visible along the full circumference of the sleeve.
    c. There shall be no wrinkling or excessive burns on the sleeves.
8. Sleeves that do not meet these requirements shall be removed and the joint recoated as directed by the Engineer. Minor repairs may be repaired using heat applied patch material specified for minor coating repairs.
9. Allow the sleeve to cool before backfilling. Water quenching will be allowed if permitted by the sleeve manufacturer.
10. Heat shrink joint coatings which have become wrinkled or disbonded because of prolonged exposure to UV light or thermal cycling shall be removed and replaced.
11. Double coating of defective or damaged heat shrink coatings will not be permitted. Any double coated heat shrink sleeves shall be immediately rejected and Contractor shall remove the existing coating and recoat the joint.

E. Cement Mortar Overcoat Coating (NOT USED)

3.7 FIELD APPLIED INTERIOR JOINT LINING

A. Mortar Lining:
1. After backfilling pipe, interior joint recess shall be filled with grout.
2. The grout shall be tightly packed into the joint recess and troweled flush with the interior surface. Excess material shall be removed from pipe.
3. At no point shall there be an indentation or projection of the mortar exceeding 1/16-inch.
4. On pipe smaller than 24-inches in diameter, bell shall be daubed with grout before the spigot is inserted into the bell. The joint shall be completed and excess mortar on the inside of the joint shall be swabbed.

3.8 REPAIR OF COATING AND LININGS

A. General:
1. All areas where holidays are detected or coating is visually damaged, such as blisters, tears, rips, bubbles, wrinkles, cuts, or other defects, shall be repaired. Areas where no holidays are detected, but are visually damaged shall also be repaired.
2. Maximum defects allowable shall be as specified herein for the coating system.

B. Tape Wrap Coating Repairs:
1. General:
    a. No more than five repairs per joint of pipe will be permitted with tape wrap coating, excluding adhesion test damage. The coating on any pipe with more

than five coating repairs or with more than two areas of coating damage greater than five square feet will be rejected.

b. Pipes exceeding the maximum number or size of coating defects shall be stripped, reblasted, and recoated.
c. Pipe arriving in the field with defects or repairs exceeding the maximum number or size of coating defects will be returned to the shop for recoating at the Contractor's expense.
d. The number of layers and total thickness of the tape repair coating shall be the same as the shop-applied coating; unless heat applied coating materials is used.
e. Wipe the area to be repaired with solvent for a minimum distance of 4 inches outside the damaged area.

2. Defect Size:
   a. Minor repairs - repairs that are less than 8 inches in the greatest dimension, measured after cutout of damaged tape layers. Damage to the inner tape layer will be considered minor only if repairs are made using heat applied patch materials.
   b. Major repairs - repairs that exceed 8-inches in the greatest dimension or where damage to the inner tape layer has occurred and hand applied tape repairs will be used.
3. Minor Repairs:
   a. Complete minor repairs using a heat applied coating patch material.
   b. Cut patch material to overlap onto the undamaged coating a minimum of 2 inches on all sides with 1-inch radius on each corner of the patch.
   c. Carefully remove damaged layers by cutting the coating with a sharp knife without cutting or damaging the inner wrap.
   d. Cut middle and outer layers in stepped fashion to expose 1-inch or more of the underlying tape layer for the circumference of the repair.
4. Major Repairs (Over 24-inches Diameter):
   a. Cigarette wrap coating repairs shall be with heat shrink sleeves as specified for joints.
   b. Carefully remove damaged layers by cutting the coating with a sharp knife without cutting or damaging the inner wrap.
   c. Holiday test the inner wrap and if a holiday is detected cut outer layers back to fully exposed the holiday(s) and retest for holidays.
   d. Cut middle and outer layers in stepped fashion to expose 1-inch or more of the underlying tape layer for the circumference of the repair.
   e. Width of sleeve shall be the width of the damaged area plus 4-inch overlap. Multiple sleeves may be used for larger repairs, but must be overlapped a minimum of 2 inches.
5. Major Repairs (24-inch Diameter or Less)
   a. Cigarette wrap repairs on pipe less than 24-inches with either hand applied tape wrap or heat shrink sleeves as specified at the Contractor's option.
   b. Carefully remove damaged layers by cutting the coating with a sharp knife without cutting or damaging the inner wrap.
   c. Holiday test the inner wrap and if a holiday is detected apply one extra layer of repair tape.
   d. Clean surfaces by solvent wiping and applying primer over the inner tape layer for a minimum of 6-inches onto the outer wrap in all directions.

e. Apply first layer of repair coating, over lapping 1-inch or more onto undamaged coating in all directions. On larger areas, lap the repair tape within a minimum of 1-inch overlap, offsetting the overlap from the previous layer overlap, until the area is properly covered.
f. Repeat for each tape layer damaged with each succeeding layer applied at 90 degrees to the preceding layers and overlapping onto the undamaged coating a minimum of 2-inches.
g. Apply the last tape layer, use the cigarette wrap method for the full pipeline circumference covering all previous repair layers and overlapping a minimum of 2-inches onto undamaged coating. The ends of the cigarette wrap shall be pointed downward.

C. Epoxy Coating or Lining Repairs
1. General
a. Complete coating or lining repairs in accordance with the coating manufacturers written instructions and these specifications, whichever is stricter.
2. Defect Size:
a. Minor repairs - repairs that are less than 8-inches in the greatest dimension.
b. Major repairs - repairs that exceed 8-inches in the greatest dimension.
3. Maximum Quantity of Defects Allowed:
a. Coating or lining repairs on any joint of pipe shall not exceed 1.5 per 100 square feet of surface area.
(1) Two or more minor repairs within a 8-inches diameter circle will be considered a single repair.
(2) Repairs for adhesion testing will not be included in the total number of repairs.
b. Major repairs shall not exceed three per pipe joint and the combined area shall not be greater than 30 percent of the pipe.
c. Pipes exceeding the maximum number or size of coating defects shall be stripped of coating, reblasted, and recoated.
d. Pipe arriving in the field with defects or repairs exceeding the maximum number or size of coating defects will be returned to the shop for recoating at the contractor's expense.
4. Minor Repairs:
a. Minor repairs
(1) Surface Preparation: Clean and feather the defect by power tool sanding with 80 grit or coarser sandpaper to roughen the existing coat and feather the edges of the defect for a minimum of 2-inches around the defect.
(2) Shop repair Materials:
(a) Single use coating kits to match the pipe coating.
(b) Two component, fast cure epoxy coating, in controlled mix ratio packaging.
a) Protal 7125, North American Denso Inc, or equal
b) Or equal.
(c) Coating Manufacturer's coating repair products are subject to Engineer approval.
(3) Field Repair Materials:

(a) Heat applied coating materials; CRP Patch, Canusa; PERP Patch, Tyco Adhesives, or approved equal.
(b) Two component, fast cure epoxy coating, in controlled mix ratio packaging.
a) Protal 7125, North American Denso, Inc,
b) Or equal.
(c) Single use coating kits to match pipe coating.
(d) Coating Manufacturer's coating repair products are subject to Engineer approval.

(4) Clean and feather the defect by power tool sanding with 80 grit or coarser sandpaper to roughen the existing coating and feather defect edges minimum of 2-inches.
(5) Apply a single coat of the specified patch coating material at the specified coating thickness.
(6) Repair coating adhesion shall be 50 percent of the specified coating adhesion.

5. Major Repairs:
a. Major repairs:
(1) Surface Preparation:
(a) The metal surface and surrounding coating shall be abrasively blasted in accordance with SSPC-SP10, near white metal, or to equal in cleanliness and profile as the original surface preparation.
(b) Existing coating shall be feathered and roughened to the equivalent of 40 grit sandpaper.
(2) Shop Repair Materials:
(a) Same material as the pipeline coating or lining and shall be applied by using plural component spray equipment.
(3) Field Repair Materials:
(a) Same material as the pipeline coating or lining and shall be applied by using plural component spray equipment.
(b) Heat shrink sleeves as specified for pipeline joints.
b. One coat of the specified original coating material shall be applied over the repaired surface at the specified thickness.
c. Repair adhesion shall be equal to the specified coating adhesion.

D. Cement Mortar Coating (NOT USED)

3.9 QUALITY CONTROL TESTING AND INSPECTION

A. General
1. Applicator shall inspect and test the coating system in accordance with referenced standards and these specifications, whichever is more stringent.
2. Quality control testing as specified in AWWA standards are minimum industry standards and it is the intent of this specification to provide a higher level of quality control for the objective of achieving maximum coating performance. If any conflict between this specification and referenced standards occurs, the more stringent requirement shall apply and any interpretation of this requirement or results shall be with the objective of achieving maximum coating performance.

3. The frequency of the testing shall be determined by the applicator, but shall not be less than the requirements of this specification.

B. Soluble Salt Contamination (SSC) Testing
   1. Residual soluble salt contamination (SSC) shall be verified using an Elcometer Model E130-TC Salt Contamination Meter before and after surface preparation.
   2. Testing after blasting is not required if the preblast test passes the maximum soluble salt contamination criteria.
   3. Maximum soluble salt contamination levels shall be:
      a. 2.0 µg/cm^2 – Immersion or buried
      b. 5.0 µg/cm^2 – non-immersion
   4. Compliance with SSC limits shall be based on the average of three tests at three locations, which can be on multiple pipes or components at the Engineer's discretion.

C. Surface Profile Testing
   1. Surface profile of abrasive blasted surfaces to be tested with "Press-O-Film" tester tape or equivalent in accordance with NACE RP287.
   2. Tester tape shall be suitable for the intended profile height.
   3. Profile shall be measured to a minimum tolerance of 0.1 mils, maximum.
   4. Electronic surface profilometer shall be used, where deemed necessary, to verify tester tape measurements.

D. Adhesion Testing
   1. General
      a. Adhesion testing shall be conducted at the shop prior to shipment. Pipe shipped without adhesion testing will be field-tested. Pipe rejected in the field will be returned to the shop for repair at the sole expense of the Contractor.
      b. Coating adhesion testing shall be conducted on each pipe lot coated. The quantity of coating adhesion tests shall be the greater of the following:
         (1) Two pipes will be tested for the first 3,000 square feet of coating application plus on additional pipe for each. increment of 2,000 square feet of coating application in excess of the first 3,000 square feet
         (2) Not less than 33 percent of each pipe produced within a lot.
      c. A pipe lot is defined as the quantity of pipe that is coated by a single crew within a 12 hour or less work shift.
      d. The pipe coating applicator shall repair all coating damage from shop adhesion testing. Contractor shall be responsible for coating repairs for all field adhesion testing.
      e. Adhesion tests will be performed not less than 24 hours after coating application. Tests conducted prior to 24-hours will be acceptable only if the test meets or exceeds the adhesion criteria specified and the test was requested by the pipe fabricator.
      f. Pipe will be randomly selected for adhesion testing.
      g. Owner or the Owner's Representative has the right to conduct additional adhesion testing as deemed necessary to assure the pipe meets or exceeds the requirements of this specification at any time and location.

h. Prior to beginning any QA/QC testing, the pipe fabricator, coating manufacturer, and Engineer shall review dolly attachment procedures, adhesion test procedures, and data recording requirements for the project and ensure that test personnel are qualified and capable of performing the testing in accordance with required test standards and these specifications.

2. Rejection of Pipeline Coating or Lining
   a. Each pipe that fails the adhesion criteria, as defined this section, shall be rejected.
   b. If any pipe within a lot that fails to meet the adhesion criteria specified for the coating type, the pipe coating will be rejected and all pipes within the lot will be classified as rejected. Each remaining pipe within the rejected pipe lot will then be individually tested and rejected on a pipe-by-pipe basis in conformance with the test procedures and criteria specific to the coating type.
   c. All rejected pipe shall have the coating fully removed from the pipe and the pipe abrasive blasted and recoated.
3. Tape Coating Adhesion Testing:
   a. Adhesion Acceptance Criteria:
      (1) Inner tape coating shall have an adhesion to substrate of 20 pounds per inch width, minimum, for steel pipe when tape is pulled in a continuous manner at an angle of 180 degrees to the pipe surface.
      (2) Inner tape coating shall have an adhesion to substrate of 15 pounds per inch width, minimum, for ductile iron pipe when tape is pulled in a continuous manner at an angle of 180 degrees to the pipe surface.
      (3) extruded polyolefin coating shall have an adhesion to substrate of 30 pounds per inch width, minimum, when coating is pulled in a continuous manner at an angle of 180 degrees to the pipe surface. Adhesion testing for extruded polyolefin shall be performed as specified for tape wrap coating.
   b. Test Procedures
      (1) Adhesion testing shall be conducted prior to application of the cement mortar overcoat, where applicable. Pipe that has been mortar coated prior to adhesion testing shall have the mortar coating removed by the Contractor as directed by the Engineer and of sufficient dimensional area to permit the adhesion test to be conducted.
      (2) Adhesion tests shall be conducted at temperatures above 60 degrees and less than 75 degrees.
      (3) Pulling tension shall be continuous, without stopping, and monitored throughout the length of the pull, which shall be not less than 12-inches in length.
      (4) Adhesion test shall be prepared by making two parallel cuts through the coating, 1-inch apart, of sufficient length for the test pull. Peel the coating back at one end and attach the tension scale to the coating with a suitable clamp. Mark the coating at one (1) inch increments from 0 to 12-inches.
      (5) The pull tension shall be recorded for each inch of pull. The two highest and two lowest readings shall be discarded and the remaining values averaged. Pull speed shall be not less than 5 seconds per inch or greater than 10 seconds per inch. If significant elongation of the tape backing

occurs, pull speeds may exceed 10 seconds per inch provided the minimum adhesion rating can still be achieved.

c. Adhesion Pull Records and Evaluation
   (1) Failure shall be by cohesive failure of the adhesive only. Delamination failure, defined as separation of the adhesive from the backing material, will result in rejection of the tape lot.
   (2) Intermittent skip failures will be counted as zero pounds of adhesion and included in the calculations for average coating adhesion.
   (3) Adhesive failure, defined as separation of the adhesive from the metal substrate, will be rejected.
   (4) Pipe that fails the test by delamination will be retested on two other pipes within the same lot of coated pipe. Failure of any two pipes within the lot will result in rejection of all pipes coated with the rejected tape lot.

4. Plural Component Epoxy Adhesion Testing:
   a. Adhesion testing shall be performed in accordance with this specification section. Adhesion testing procedures and evaluations per AWWA C210 or C222 are specifically excluded under this specification.
   b. Test Procedures
      (1) Coating adhesion testing shall be with self-aligning pneumatic pull off equipment, such as the Delfesko Positest AT-A, and test procedures in accordance with ASTM D4541, except as modified in this section.
         (a) All adhesion tests shall be performed at an applied load rate of 100 psi per second, plus or minus 10 psi. Automatic adhesion test equipment shall be used.
         (b) Tests shall be performed to coating or glue failure or maximum test load, whichever is greater.
         (c) Adhesion tests shall be based on the ASTM D4541 using standard 20 mm dollies.
         (d) Adhesion testing shall be based on three tests. All three tests shall be conducted by the same person, test equipment, and test procedure, and must be completed within a 30 minute period.
         (e) All adhesion tests shall be conducted within an area not to exceed 6-inches by 6-inches.
         (f) All coatings with more than 10 percent elongation or 25 mils thick shall be scored around dolly to metal substrate using manual methods and tools, normal to the pipe surface, and in a manner that does not stress or over heat the coating.
         (g) All adhesion tests shall be performed to coating or glue failure or test termination, whichever comes first.
      (2) Dollies for adhesion testing shall attached to the coating surface using an two part epoxy or cyanoacrylate glue and allowed to cure for a minimum of 12 hours before testing or until full cure, whichever is greater. Glue type used shall be determined by the pipe fabricator and coating manufacturer for the pipe diameter, temperatures, and environmental conditions.
      (3) Adhesion testing shall be performed at temperatures between 55 and 90 degrees F or at temperatures as recommended by the coating manufacturer. Testing up to 115 degrees F or below 55 degrees will be

permitted if tests can demonstrate no statistically detectable effect on test results and with coating manufacturer and Engineer approval.

c. Epoxy Coating and Lining Adhesion Criteria
   (1) Coating is acceptable if first dolly pull test exceeds 1,750 psi, minimum.
   (2) If first dolly pull is less than 1,750 psi, two additional tests shall be performed with acceptance based on "Best of Three" evaluation method as defined herein.

d. Pipe Lot Performance Criteria:
   (1) Each lot of coated pipe shall be evaluated for general coating application based on a median value for all coating or lining adhesion tests performed on a lot of pipe, which shall be greater than 2,000 psi.
   (2) Any pipe lot failing the Pipe Lot Performance Criteria shall be classified as rejected until 100 percent of the pipe within the pipe lot has been tested for adhesion. Each pipe that fails the coating adhesion criteria shall be rejected.

e. Adhesion Test Evaluation and Records
   (1) The "Best of three" evaluation method shall be defined as two of three test values less than the Acceptance Criteria, which shall result in rejection of the pipe coating.
   (2) All adhesion tests shall be considered as valid and suitable for acceptance or rejection of the coating, except where retesting is allowed.
   (3) Adhesion test failure shall be by adhesive or substrate and cohesive failure as defined below:
      (a) Adhesive or substrate failure is defined as a percentage of separation of the coating from the steel substrate or between distinct coating layers.
      (b) Cohesive failure is defined as a percentage of failure within the coating, resulting in coating remaining both on the steel substrate and test dolly.
   (4) Retesting of coating adhesion tests will be allowed when any test is glue failure at 25 percent or more of dolly surface area and the test value is less than the Acceptance Criteria or the Minimum Criteria.
   (5) All coating adhesion retesting shall be within the same 6-inch by 6-inch test area as the original adhesion testing.
   (6) Disputed adhesion tests shall be retested as defined for adhesion retesting. Dolly attachment and adhesion retesting shall be witnessed by the Owner's representative.
   (7) Adhesion tests will be conducted on pipe coating and lining independently and will be accepted or rejected independently.
   (8) Records of all adhesion tests shall be maintained in an electronic spreadsheet that includes the following information:
      (a) Pipe identification,
      (b) Pipe coating date,
      (c) Adhesion test date,
      (d) Surface tested (interior or exterior),
      (e) Surface temperature at time of test,
      (f) Coating thickness,
      (g) tensile force applied,
      (h) Applied load rate per second,

(i) Mode of failure, and
(j) Percentage of failure types, previously defined, relative to dolly surface area,
(k) Dolly size and attachment glue used.
(l) If different coatings are tested, the records shall include coating manufacturer and product number.

f. Adhesion Test Repairs
(1) Fabricator or contractor to complete adhesion repairs as specified this section.
(2) Repair patches on epoxy coating shall be randomly selected for adhesion testing in a manner as described herein and at the discretion of the coating inspector conducting the adhesion tests. Adhesion of repairs shall be as specified for the type of repair.

E. Holiday Testing
1. Holiday test the inner layer of tape wrap coatings after application and prior to subsequent tape layer in accordance with AWWA C214 and NACE RP-0274.
2. Holiday test extruded polyolefin coating after application in accordance with AWWA C215 and NACE Standard RP-0274, whichever is more stringent.
3. Holiday tests on epoxy coatings or linings over 15 mils DFT shall be conducted on the completed coating or lining after cure or 24-hours, whichever is less, using a high voltage spark test in accordance with NACE SP0274 and these specifications.
4. Holiday testing on epoxy coatings or linings less than 15 mils DFT shall be high voltage spark tested in accordance with NACE SP0188, except as modified herein.
5. High voltage setting shall be the average measured coating thickness in mils times 125 volts, minimum.
6. Wet sponge or low voltage holiday testing will not be permitted.

F. Dry Film Thickness Testing
1. Coatings shall be tested for dry film thickness using a properly calibrated magnetic pull off, eddy current, or ultrasonic equipment.
2. Coating thickness measurements shall be conducted as necessary and without limitation. Testing conformance to the requirements of SSPC PA-2 is specifically excluded from this specification.

G. Salt Contamination Testing
1. Engineer shall perform salt contamination testing with an Elcometer Model E130-TC Salt Contamination meter as defined under Surface Preparation.
2. Quantity of tests performed shall be determined the Engineer based on prevailing field conditions.
3. Objective is to assess and remove wind borne salts contamination on surfaces to be coated. Because wind and environmental conditions can change the frequency and location of testing may need to be varied.
4. At a minimum, tests should be performed daily before and after pressure washing of surfaces to be coated.
5. Surfaces identified to be excessively contaminated shall be cleaned by the Contractor to meet the acceptance criteria specified under Surface Preparation.

3.10 HANDLING, TRANSPORTATION, AND STORAGE

A. Pipe shall be handled in such a manner as to protect the pipe and coating from damage.

B. Coated pipe shall not be shipped or installed until coating has developed full adhesion and cure.

C. During coating application, storage, loading, transportation, unloading, laying and installation, every precaution shall be taken to protect and prevent damage to pipe, lining, and coating. Forklift equipment shall have all bearing surfaces padded with suitable padding material. Lift pipe with web slings a minimum of 12-inch wide and of a type that will not damage the coating. Metal chains, cable, tongs, forklifts or other equipment likely to damage the coating will not be permitted. Dragging or skidding of pipe on grade or in the trench will not be permitted.

D. Provide transportation vehicles with padded bolsters between each layer of pipe and heavy padding under load ties. Bolsters shall be curved to fit the outside of the pipe and 12 inches wide, minimum. All pipe contact locations shall be heavily padded with carpet and strips of the outer tape wrap material (adhesive side against the carpet) during shipment to the project site and from the storage yard to the point of installation.

E. Pipe shall not be stored on rocks, gravel, or other hard materials that might damage the coating. Provide padded 12-inch wide skids and chucks, sand bags, select loamy or sand berms, or suspended from cutback ends, where possible, to minimize coating damage. Pipe shall not be laid on asphalt without suitable padding at all contact points.

F. Pipe shall be inspected by the Contractor at the project site for damage. Any damage to the pipe, lining, or coating shall be repaired as directed if, in the opinion of the Engineer, a satisfactory repair can be made; otherwise, the damaged section shall be replaced at the sole expense to the Contractor.

G. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workmen shall not be permitted to walk on the coating except when necessary and approved by the Engineer. When permitted, shoes with rubber or composition soles and heels or other suitable footwear that will not damage coating shall be used.

H. Long-term Exposure:
   1. Pipe shall either be provided with UV inhibitor for lengthy of above grade exposure or covered to prevent UV degradation of outer wrap.
   2. Amount of UV stabilizers required will depend on the project location, laying schedule, anticipated length of exposure, and type of coating.
   3. Manufacturer shall be consulted for recommended UV inhibitors requirements.
   4. Protective covering can be colored plastic sheeting, canvas, or other UV blocking material. Clear plastic sheets are not acceptable.
   5. Areas of coating that display UV degradation shall be removed and repaired at sole cost of the Contractor.

END OF SECTION

DIVISION 10
SPECIALTIES

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SECTION 10 11 00
VISUAL DISPLAY UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Visual display board assemblies.
2. Modular support systems for visual display board assemblies.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.
2. Include electrical characteristics for motorized units.

B. Shop Drawings: For visual display units.
1. Include plans, elevations, sections, details, and attachment to other work.
2. Include sections of typical trim members.

C. Samples for Initial Selection: For each type of visual display unit indicated, for units with factory-applied color finishes, and as follows:
1. Samples of facings for each visual display panel type, indicating color and texture.
2. Actual factory-finish color samples, applied to aluminum substrate.
3. Include accessory Samples to verify color selected.

D. Samples for Verification: For each type of visual display unit indicated.
1. Visual Display Panel: Not less than 8-1/2 by 11 inches (215 by 280 mm), with facing, core, and backing indicated for final Work. Include one panel for each type, color, and texture required.
2. Trim: 6-inch- (150-mm-) long sections of each trim profile.
3. Accessories: Full-size Sample of each type of accessory.

E. Product Schedule: For visual display units. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of tackboards.

C. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For visual display units to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-fabricated visual display units completely assembled in one piece. If dimensions exceed maximum manufactured unit size, or if unit size is impracticable to ship in one piece, provide two or more pieces with joints in locations indicated on approved Shop Drawings.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Field Measurements: Verify actual dimensions of construction contiguous with visual display units by field measurements before fabrication.
   1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

1.9 WARRANTY

A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Surfaces lose original writing and erasing qualities.
      b. Surfaces exhibit crazing, cracking, or flaking.
   2. Warranty Period: Life of the building.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of visual display unit from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 VISUAL DISPLAY BOARD ASSEMBLY

A. Visual Display Board Assembly: Field or factory fabricated.
1. Assembly: Markerboard.
2. Corners: Square.
3. Width: As indicated on Drawings.
4. Height: As indicated on Drawings.
5. Mounting Method: Direct to wall.

B. Markerboard Panel: Porcelain-enamel-faced markerboard panel on core indicated.
1. Color: White.

C. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- (1.57-mm-) thick, extruded aluminum; standard size and shape.
1. Field-Applied Trim: Manufacturer's standard.
2. Aluminum Finish: Clear anodic finish.

D. Joints: Make joints only where total length exceeds maximum manufactured length. If joints are necessary, divide into combination assemblies in lieu of joints.

E. Combination Assemblies: Provide manufacturer's standard exposed trim between abutting sections of visual display panels.

F. Chalktray: Manufacturer's standard; continuous.
1. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.

2.4 MARKERBOARD PANELS

A. Porcelain-Enamel Markerboard Panels: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction, consisting of moisture-barrier backing, core material, and porcelain-enamel face sheet with low-gloss finish. Laminate panels under heat and pressure with manufacturer's standard, flexible waterproof adhesive.
1. Face Sheet Thickness: 0.021 inch (0.53 mm) uncoated base metal thickness.
2. Manufacturer's Standard Core: Minimum 1/4 inch (6 mm) thick, with manufacturer's standard moisture-barrier backing.
3. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.

2.5 MATERIALS

A. Porcelain-Enamel Face Sheet: PEI-1002, with face sheet manufacturer's standard two- or three-coat process.

B. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063.

C. Adhesives for Field Application: Mildew-resistant, nonstaining adhesive for use with specific type of panels, sheets, or assemblies; and for substrate application; as recommended in writing by visual display unit manufacturer.
   1. Adhesives shall have a VOC content of 50 g/L or less.
   2. Adhesives shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in Section 099123 "Interior Painting" and recommended in writing by visual display unit manufacturer for intended substrate.

2.6 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical power systems to verify actual locations of connections before installation of motorized, sliding visual display units.

C. Examine walls and partitions for proper preparation and backing for visual display units.

D. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances, such as dirt, mold, and mildew, that could impair the performance of and affect the smooth, finished surfaces of visual display boards.

C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display units and wall surfaces.

D. Prime wall surfaces indicated to receive visual display units and as recommended in writing by primer/sealer manufacturer and visual display unit manufacturer.

E. Prepare recesses for sliding visual display units as required by type and size of unit.

3.3 INSTALLATION

A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

B. Visual Display Board Mounting Heights: Install visual display units at mounting heights indicated on Drawings, or if not indicated, at heights indicated below.
   1. Mounting Height for Grades 7 and Higher: 36 inches (914 mm) above finished floor to top of chalktray.
   2. Hang visual display units on rail support system.

3.4 CLEANING AND PROTECTION

A. Clean visual display units according to manufacturer's written instructions. Attach one removable cleaning instructions label to visual display unit in each room.

B. Touch up factory-applied finishes to restore damaged or soiled areas.

C. Cover and protect visual display units after installation and cleaning.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain motorized, sliding visual display units.

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SECTION 10 14 00
SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY OF WORK

A. This Section includes the following types of signs:
   1. Plant Entrance Sign
   2. Panel signs.
      a. Interior room identification signs.
      b. Handicap accessibility signage.
      c. Parking signs (handicapped).
      d. Handicap entry signs.
      e. Site directional signs.
      f. Maximum occupancy load signs.
   3. Dimensional letters and numbers.
   4. Building address.

B. Related Sections include the following:
   1. Division 1 Section "LEED Requirements" for LEED certification targets, related LEED requirements, recycled content minima, other LEED criteria and constraints.
   2. Information attached for reference, including LEED Checklist for Project building(s), indicating which LEED credits are targeted for attainment.
   3. LEED reference documents, not attached but available for use, including the "LEED-New Construction v.2.2 Rating System," explaining requirements for each prerequisite and credit, and the "LEED-New Construction v2.2 Reference Guide," detailing requirements and documentation options for application for each prerequisite and credit.

1.2 CONTRACTOR SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for each type of sign specified, including details of construction relative to materials, dimensions of individual components, profiles, and finishes.

C. Shop drawings showing fabrication and erection of signs. Include plans, elevations, and large scale sections of typical members and other components. Show anchors, grounds, layout, reinforcement, accessories, and installation details.
   1. Provide message list for each sign required, including large scale details of wording and lettering layout.
   2. For signs supported by or anchored to permanent construction, provide setting drawings, templates, and directions for installation of anchor bolts and other anchors to be installed as a unit of Work in other Sections.
   3. Templates: Furnish full size spacing templates for individually mounted dimensional letters and numbers.
   4. Furnish full size layouts for metal plaques.

D. Samples: Provide the following samples of each sign component for initial selection of color, pattern and surface texture as required and for verification of compliance with requirements indicated.
   1. Samples for selection of color, pattern, and texture:
      a. Cast Acrylic Sheet and Plastic Laminate: Manufacturer's color charts consisting of actual sections of material including the full range of colors available for each material required.
      b. Aluminum: Samples of each finish type and color, on 6 inch long sections of extrusions and not less than 4 inch squares of sheet or plate, showing the full range of colors available.

1.3 QUALITY ASSURANCE

A. Sign Fabricator Qualifications: Firm experienced in producing signs similar to those indicated for this Project, with a record of successful in service performance, and sufficient production capacity to produce sign units required without causing delay in the Work.

B. Single Source Responsibility: For each separate sign type required, obtain signs from one source of a single manufacturer.

C. Handicapped Accessibility: Provide signs which are in conformance with the requirements of ANSI A117.1-2003 and the Americans with Disabilities Act of 1990 (ADA).

D. Design Concept: The Drawings indicate sizes, profiles, and dimensional requirements of signs and are based on the specific types and models indicated. Sign units by other manufacturers may be considered provided deviations in dimensions and profiles do not change the design concept as judged by the Architect. The burden of proof of equality is on the proposer.

1.4 DELIVERY AND HANDLING

A. Delivery: Provide protective covering or crating as recommended by the manufacturer to protect sign components and surfaces against damage during transportation and delivery.

B. Handle signs carefully to prevent breakage, surface abrasion, denting, soiling, and other defects. Comply with the manufacturer's written handling instructions for unloading components subject to damage.
   1. Inspect sign components for damage on delivery.
   2. Do not install damaged sign components.
   3. Repair minor damage to signs, provided the finished repair is equal in all respects to the original work and is approved by Architect; otherwise, remove and replace damaged sign components.

1.5 PROJECT CONDITIONS

A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay.

1.6 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Fiberglass Panel Sign Warranty: Submit a written warranty, signed by manufacturer, agreeing to repair or replace fiberglass panels that fail during the specified warranty period. Failures include, but are not limited to, the following:
   1. Coating degradation.
   2. Chalking.
   3. Fading.
   4. Fiberglass delamination or cracking.

C. Warranty Period: 5 years.

PART 2 - PRODUCTS

2.1 PLANT ENTRANCE SIGN

A. Contractor to include an allowance of $2,000 for the entrance sign for the FRWTP facility. This includes work for supplying and construction the sign, including excavation, foundation preparation, concrete work, sign structure, and sign materials. Owner will develop a sign design, overall look, and sizing and provide to the Contractor for quotes and final installation.

2.2 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
   1. Manufacturers of Panel Signs:
      a. ABC Architectural Signing System.
      b. ASI Sign Systems, Inc.
      c. Best Manufacturing Company.
      d. Spanjer Brothers, Inc.
      e. Vomar Products, Inc.
   2. Manufacturers of Dimensional Letters:
      a. ASI Sign Systems, Inc.
      b. Metal Arts.
      c. Metallic Arts, Inc.
      d. The Southwell Company.
      e. Spanjer Brothers, Inc.
      f. Vomar Products, Inc.

2.3 MATERIALS

A. Steel Tubing: Cold-formed steel tubing conforming to ASTM A 500, Grade B, hot-dip galvanized after fabrication with a minimum of 2.0 oz. of zinc/sq. ft. (610 g of zinc/sq. m) of surface area conforming to ASTM A 123.

B. Fiberglass: Molded, seamless, thermosetting, glass-fiber-reinforced polyester panels in sizes and thicknesses indicated, with a minimum tensile strength of 15,000 psi (103 MPa) when tested according to ASTM D 638 (ASTM D 638M) and with a minimum flexural strength of 30,000 psi (207 MPa) when tested according to ASTM D 790 (ASTM D 790M).

C. Cast Acrylic Sheet: Provide cast (not extruded or continuous cast) methyl methacrylate monomer plastic sheet, in sizes and thicknesses indicated, with a minimum flexural strength of 16,000 psi when tested according to ASTM D 790, with a minimum allowable continuous service temperature of 176 deg F (80 deg C), and of the following general types:
   1. Opaque Sheet: Where sheet material is indicated as "opaque," provide colored opaque acrylic sheet in colors and finishes as selected from the manufacturer's standards.

D. Aluminum Castings: Provide aluminum castings of alloy and temper recommended by the sign manufacturer for the casting process used and for the use and finish indicated.

E. Fasteners: Use concealed fasteners fabricated from metals that are not corrosive to the sign material and mounting surface.

F. Anchors and Inserts: Use nonferrous metal or hot dipped galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion bolt devices for drilled in place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

G. Concrete for Post Holes: Mix portland cement complying with ASTM C 150, aggregates complying with ASTM C 33, and clean water to obtain concrete with a minimum 28-day compressive strength of 2500 psi (17 MPa). Use at least 4 sacks of cement/cu. yd. (225 kg of cement/cu. m), 1-inch (25-mm) maximum-size aggregate, maximum 3-inch (75-mm) slump, and 2 to 4 percent entrained air.

2.4 PANEL SIGNS

A. General: Provide panel signs that comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.
   1. Produce smooth panel sign surfaces constructed to remain flat under installed conditions within tolerance of plus or minus 1/16 inch1.5 mm measured diagonally.

B. Basis of Design Product: ASI Sign Systems, Inc.; ASI Tactile Graphics Plaque Sign System or a comparable product of one of the following:
   1. Available Manufacturers:
      a. APCO Graphics, Inc.
      b. Best Manufacturing Co.
      c. Mohawk Sign Systems.

C. Sign Face: High impact aluminum tri-hydrate filled polyester acrylate resin, pressure molded into a single polymerized component, using manufacturers standard co-molding process.

D. Unframed Panel Signs: Fabricate signs with edges mechanically and smoothly finished to comply with the following requirements:
   1. Edge Condition: Square cut.

2. Corner Condition: Square.
3. Depth: 0.25 inch thickness.
4. Panel Appearance: As selected by Architect.
5. Color: As selected by Architect from manufacturer=s full range of colors.
6. Surface Texture: As selected by Architect.
7. Letter Style: Arial.
8. Letter Height: As scheduled.

E. Brackets: Fabricate brackets and fittings for bracket mounted signs from extruded aluminum to suit panel sign construction and mounting conditions indicated. Background chassis shall be concealed by modules and accessories.

F. Graphic Content and Style: Provide sign copy that complies with requirements indicated in the Sign Schedule for size, style, spacing, content, mounting height and location, material, finishes, and colors of signage.
1. Provide signage indicating handicap entry at each set of entry doors into facility.
2. Provide one wall mounted sign per door or set of doors throughout building.
   a. Provide signs with cutouts and removable inserts (maximum of three (3) per sign) with permanent ADA text.
3. Provide maximum occupancy load signs in assembly rooms as required by code.

G. Tactile and Braille Copy: Manufacturer's standard process for producing copy complying with ADA Accessibility Guidelines and ICC/ANSI A117.1. Text shall be accompanied by Grade 2 braille. Produce precisely formed characters with square cut edges free from burrs and cut marks.
1. Raised Copy Thickness: Not less than 1/32 inch0.8 mm.

H. Changeable Message Inserts: Fabricate signs to allow insertion of changeable messages in the form of transparent covers with paper inserts printed by Owner.
1. Furnish paper and software for creating text and symbols for IBM compatible computers for Owner production of paper inserts.
2. Furnish paper cut to size for changeable message insert.

I. Colored Coatings: For copy and background colors, provide Pantone Matching System (PMS) colored coatings, including inks and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are nonfading for application intended.

J. Applied Copy: Die cut characters from vinyl film of nominal thickness of 3 mils (0.076 mm) with pressure sensitive adhesive backing. Apply copy to exposed face of panel sign, glass, doors, or wall surfaces as indicated.

K. Back-up Sign Panel: Provide back-up blank sign panels at all glass mounted sign locations. Back-up sign panel shall match finished sign face and shall be used to conceal sign attachment to glass. Back-up blank sign panels shall be used or located as directed by Architect.

2.5 EXTERIOR DIRECTIONAL AND PARKING SIGNS

A. Panel Signs: Comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.

1. Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch measured diagonally.

B. Steel Posts: 0.120-inch- (3.0-mm-), galvanized, seamless, square steel posts in length adequate for mounting method specified. Include post caps, fillers, spacers, junction boxes, access panels, and related accessories required for a complete installation. Comply with the following requirements for post shape, finish, and mounting method indicated:
   1. Post Size: 2 by 2 inches (50 by 50 mm) square.
   2. Post Mounting Method: Provide sign posts of length required for permanent installation by direct-burial mounting method.

C. Sign Panels: Provide smooth, even, level sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch (1.5 mm) measured diagonally from corner to corner.
   1. Unframed Single-Sheet Panels: Provide unframed single-sheet sign panels with edges mechanically and smoothly finished to conform to the following:
      a. Panel Material: 0.125-inch- (3.2-mm-) thick fiberglass sheet.
         1) Panel Finish: Manufacturer's standard semigloss finish with UV inhibitors.
      b. Edge Condition: Square cut.
      c. Corner Condition: Square corners.

D. Graphic Content and Style: Provide sign copy that complies with the requirements indicated for size, style, spacing, content, position, material, finishes, and colors of letters, numbers, and other graphic devices.
   1. Copy Embedded in Fiberglass Panels: Apply computer-generated adhesive graphics to panel as a masking material. Apply acrylic polyurethane background-color flood coats, 0.015-inch (0.4-mm) minimum thickness. Include UV inhibitors. Remove masking material.
      a. Provide signage indicating handicap parking at all handicap parking spaces.
      b. Provide directional signage on site for bus, automobile and pedestrian access.

E. Fabrication: Provide manufacturer's standard single-post, single-panel-type post and panel signs. The completed sign assembly shall consist of a message panel supported on 1 post. Comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.
   1. Allow for thermal movement resulting from a maximum ambient temperature change (range) of 100 deg F (38 deg C). Design, fabricate, and install post and panel sign assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners.
   2. Base design on actual surface temperatures of metals due to both solar heat gain and nighttime-sky heat loss.
      a. Welded Connections: Comply with AWS standards for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded surfaces of welding flux and dress on exposed and contact surfaces.
      b. Mill joints to a tight, hairline fit. Form joints exposed to the weather to exclude water penetration.

c. Preassemble signs in the shop to the greatest extent possible to minimize field assembly. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in a location not exposed to view after final assembly.

d. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

3. Posts: Fabricate posts to lengths required for mounting method indicated.

a. Direct Burial: For permanent sign installation, provide posts 36 inches (900 mm) longer than height of sign to permit direct embedment in concrete foundations.

4. Panels: Form panels to required size and shape. Comply with requirements indicated for design, dimensions, finish, color, and details of construction.

a. Coordinate dimensions and attachment methods to produce message panels with closely fitting joints. Align edges and surfaces with one another in the relationship indicated.

b. Increase metal thickness or reinforce with concealed stiffeners or backing materials as required to produce surfaces without distortion, buckles, warp, or other surface deformations.

c. Continuously weld joints and seams, unless other methods are indicated; grind, fill, and dress welds to produce smooth, flush, exposed surfaces with welds invisible after final finishing.

2.6 DIMENSIONAL LETTERS AND NUMBERS

A. Cast Letters and Numbers: Form individual letters and numbers by casting. Produce characters with smooth, flat faces, sharp corners, and precisely formed lines and profiles, free from pits, scale, sand holes, or other defects. Cast lugs into the back of characters and tap to receive threaded mounting studs. Comply with requirements indicated for finish, style, and size.

1. Metal: Aluminum.
2. Provide letters of size and style as indicated attached to exterior building and monument sign surface as directed by architect.
3. Building Address: Provide letters and/or numbers as required. Attach to exterior wall surface as directed by architect.

2.7 FINISHES

A. Colors and Surface Textures: For exposed sign material that requires selection of materials with integral or applied colors, surface textures or other characteristics related to appearance, provide color matches indicated, or if not indicated, as selected by the Architect from the manufacturer's standards.

B. Metal Finishes: Comply with NAAMM "Metal Finishes Manual" for finish designations and applications recommendations.

C. Aluminum Finishes: Finish designations prefixed by "AA" conform to the system established by the Aluminum Association for designating aluminum finishes.

1. Baked Enamel Finish: AA M4xC12C42R1x (Mechanical Finish: Manufacturer's standard, other nondirectional textured; Chemical Finish: Chemical conversion

coating, acid chromate fluoride phosphate pretreatment; Organic Coating: as specified below). Apply baked enamel in compliance with paint manufacturer's specifications for cleaning, conversion coating, and painting.

a. Organic Coating: Thermosetting modified acrylic enamel primer/topcoat system complying with AAMA 603.8 except with a minimum dry film thickness of 1.5 mils, medium gloss.

1) Color: As selected by the Architect from the manufacturer's standard colors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Locate sign units and accessories where indicated, using mounting methods of the type described and in compliance with the manufacturer's instructions.

1. Install signs level, plumb, and at the height indicated, with sign surfaces free from distortion or other defects in appearance.

B. Exterior Directional and Parking Signs:

1. Excavation: In firm, undisturbed or compacted soil, drill or (using a post-hole digger) hand-excavate holes for each post to the minimum diameter recommended by sign manufacturer, but at least 4 times the largest post cross-section.

a. Excavate hole depths approximately 3 inches (75 mm) lower than required post bottom, with bottom of posts set at least 36 inches (900 mm) below finished grade.

2. Setting Posts: Center and align posts in holes 3 inches (75 mm) above bottom of excavation.

a. Protect portion of posts aboveground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Check posts for vertical and top alignment and hold in position until concrete has achieved its initial set.

C. Wall Mounted Panel Signs: Attach panel signs to wall surfaces using the methods indicated below:

1. Provide screws, bolts, and other exposed fastening devices of the same material as the items being fastened. Provide types, gages, and lengths to suit installation conditions. Use theft-proof fasteners where exposed to view.

D. Bracket Mounted Units: Provide the manufacturer's standard brackets, fittings, and hardware as appropriate for mounting signs that project at right angles from walls and ceilings. Attach brackets and fittings securely to walls or ceilings with concealed fasteners and anchoring devices to comply with manufacturer's directions.

E. Dimensional Letters and Numbers: Mount letters and numbers using standard fastening methods recommended by the manufacturer for letter form, type of mounting, wall construction, and condition of exposure indicated. Provide heavy paper template to establish letter spacing and to locate holes for fasteners.

1. Flush Mounting: Mount letters with backs in contact with the wall surface.

3.2 CLEANING AND PROTECTION

A. After installation, clean soiled sign surfaces according to the manufacturer's instructions. Protect units from damage until acceptance by the Owner.

END OF SECTION

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SECTION 10 21 13.13
METAL TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes painted steel toilet compartments configured as toilet enclosures and urinal screens.

B. Related Requirements:
1. Section 05 50 00 "Metal Fabrications" for supports that attach floor-and-ceiling-anchored compartments to overhead structural system.
2. Section 06 10 00 "Rough Carpentry" Section 06 10 53 "Miscellaneous Rough Carpentry" for blocking and overhead support of floor-and-ceiling-anchored compartments.
3. Section 10 28 00 "Toilet, Bath, and Laundry Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories mounted on toilet compartments.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.

B. Shop Drawings: For toilet compartments.
1. Include plans, elevations, sections, and attachment details.
2. Show locations of cutouts for compartment-mounted toilet accessories.
3. Show locations of reinforcements for compartment-mounted grab bars and locations of blocking for surface-mounted toilet accessories.
4. Show locations of centerlines of toilet fixtures.
5. Show locations of floor drains.
6. Show overhead support or bracing locations.

C. Samples for Initial Selection: For each type of toilet compartment material indicated.
1. Include Samples of hardware and accessories involving material and color selection.

D. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
1. Each type of material, color, and finish required for toilet compartments, prepared on 6-inch- (152-mm-) square Samples of same thickness and material indicated for Work.
2. Each type of hardware and accessory.

E. Product Schedule: For toilet compartments, prepared by or under the supervision of supplier, detailing location and selected colors for toilet compartment material.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of toilet compartment.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Door Hinges: One hinge(s) with associated fasteners.
   2. Latch and Keeper: One latch(es) and keeper(s) with associated fasteners.
   3. Door Bumper: One door bumper(s) with associated fasteners.
   4. Door Pull: One door pull(s) with associated fasteners.
   5. Fasteners: 10 fasteners of each size and type.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Recycled Content of Metal Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for toilet compartments designated as accessible.

2.2 PAINTED STEEL TOILET COMPARTMENTS

A. Basis of Design: General Partitions – Powder Coated Steel, Series 60

B. Toilet-Enclosure Style: Floor mounted overhead braced.

C. Urinal-Screen Style: Post to ceiling.

D. Door, Panel, and Pilaster Construction: Seamless, metal facing sheets pressure laminated to core material; with continuous, interlocking molding strip or lapped-and-formed edge closures; corners secured by welding or clips and exposed welds ground smooth. Provide

with no-sightline system. Exposed surfaces shall be free of pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections.

1. Core Material: Manufacturer's standard sound-deadening honeycomb of resin-impregnated kraft paper in thickness required to provide finished thickness of 1 inch (25 mm) for doors and panels and 1-1/4 inches (32 mm) for pilasters.
2. Grab-Bar Reinforcement: Provide concealed internal reinforcement for grab bars mounted on units of size and material adequate for panel to withstand applied downward load on grab bar of at least 250 lbf (1112 N), when tested according to ASTM F 446, without deformation of panel.
3. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to units.

E. Urinal-Screen Construction:

1. Flat-Panel Urinal Screen: Matching panel construction.
2. Integral-Flange, Wall-Hung Urinal Screen: Similar to panel construction, with integral full-height flanges for wall attachment, and maximum 1-1/4 inches (32 mm) thick.
3. Wedge-Shaped, Wall-Hung Urinal Screen: Similar to panels, V-shaped, fabricated for concealed wall attachment, and maximum 6 inches (152 mm) wide at wall and minimum 1 inch (25 mm) wide at protruding end.

F. Facing Sheets and Closures: Electrolytically coated steel or hot-dip galvanized-steel sheet with nominal base-metal (uncoated) thicknesses as follows:

1. Pilasters, Braced at Both Ends: Manufacturer's standard thickness, but not less than 0.036 inch (0.91 mm).
2. Panels: Manufacturer's standard thickness, but not less than 0.030 inch (0.76 mm).
3. Doors: Manufacturer's standard thickness, but not less than 0.030 inch (0.76 mm).
4. Flat-Panel Urinal Screens: Thickness matching the panels.

G. Pilaster Shoes: Stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.

H. Urinal-Screen Post: Manufacturer's standard post design of material matching the thickness and construction of pilasters or 1-3/4-inch- (44-mm-) square, aluminum tube with satin finish; with shoe matching that on the pilaster.

1. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel or aluminum.

I. Steel Sheet Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked-on finish, including thermosetting, electrostatically applied, and powder coatings. Comply with coating manufacturer's written instructions for applying and baking.

1. Color: As selected by Architect from manufacturer's full range.
    a. Allow for application of one color in each room.

2.3 HARDWARE AND ACCESSORIES

A. Hardware and Accessories: Manufacturer's heavy-duty operating hardware and accessories.
   1. Hinges: Manufacturer's minimum 0.062-inch- (1.59-mm-) thick, stainless-steel paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees, allowing emergency access by lifting door. Mount with through-bolts.
   2. Latch and Keeper: Manufacturer's heavy-duty, surface-mounted, cast stainless-steel latch unit designed to resist damage due to slamming, with combination rubber-faced door strike and keeper and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible. Mount with through-bolts.
   3. Coat Hook: Manufacturer's heavy-duty, combination cast stainless-steel hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories. Mount with through-bolts.
   4. Door Bumper: Manufacturer's heavy-duty, rubber-tipped, cast stainless-steel bumper at out-swinging doors. Mount with through-bolts.
   5. Door Pull: Manufacturer's heavy-duty cast stainless-steel pull at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible. Mount with through-bolts.

B. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.4 MATERIALS

A. Aluminum Castings: ASTM B 26/B 26M.

B. Aluminum Extrusions: ASTM B 221 (ASTM B 221M).

C. Steel Sheet: Commercial steel sheet for exposed applications; mill phosphatized and selected for smoothness.
   1. Electrolytically Zinc Coated: ASTM A 879/A 879M, 01Z (03G).
   2. Hot-Dip Galvanized: ASTM A 653/A 653M, either hot-dip galvanized or galvannealed.

D. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness.

E. Stainless-Steel Castings: ASTM A 743/A 743M.

F. Zamac: ASTM B 86, commercial zinc-alloy die castings, chrome plated.

2.5 FABRICATION

A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories, and solid blocking within panel where required for attachment of toilet accessories.

B. Floor-and-Ceiling-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.

C. Urinal-Screen Posts: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment at tops and bottoms of posts. Provide shoes at posts to conceal anchorage.

D. Door Size and Swings: Unless otherwise indicated, provide 24-inch- (610-mm-) wide, in-swinging doors for standard toilet compartments and 36-inch- (914-mm-) wide, out-swinging doors with a minimum 32-inch- (813-mm-) wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.

1. Confirm location and adequacy of blocking and supports required for installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Coordinate layout and installation of supports, inserts, and anchors built into other units of work for toilet compartment anchorage.

3.2 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position indicated with manufacturer's recommended anchoring devices.

1. Maximum Clearances:
   a. Pilasters and Panels: 1/2 inch (13 mm).
   b. Panels and Walls: 1 inch (25 mm).

2. Full-Height (Continuous) Brackets: Secure panels to walls and to pilasters with full-height brackets.
   a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
   b. Align brackets at pilasters with brackets at walls.

B. Floor-and-Ceiling-Anchored Units: Secure pilasters to supporting construction and level, plumb, and tighten. Hang doors and adjust so doors are level and aligned with panels when doors are in closed position.

C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.3 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION

SECTION 10 26 50
IMPACT-RESISTANT WALL PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Corner guards – Within interior of building, provide and install corner protection on all outside corners of gypsum board walls, unless indicated otherwise on Drawings.

B. Related Sections include the following:
   1. Division 8 Section "Door Hardware" for metal armor, kick, mop, and push plates.

1.3 PERFORMANCE REQUIREMENTS

1.4 SUBMITTALS

A. Product Data: Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes for each impact-resistant wall-protection unit.

B. Shop Drawings: For each impact-resistant wall-protection unit showing locations and extent. Include sections, details, and attachments to other work.
   1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Product Information for Initial Selection: For each type of impact-resistant wall-protection unit indicated.

D. Maintenance Data: For each impact-resistant wall-protection unit to include in maintenance manuals.
   1. Include recommended methods and frequency of maintenance for maintaining optimum condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to plastic finishes and performance.

E. Warranty: Special warranty specified in this Section.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Corner-Guard Covers: Full-size plastic covers of maximum length equal to 2 percent of each type, color, and texture of cover installed, but no fewer than two, 48-inch-long units.
2. Mounting and Accessory Components: Amounts proportional to the quantities of extra materials. Package mounting and accessory components with each extra material.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Source Limitations: Obtain impact-resistant wall-protection units through one source from a single manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store impact-resistant wall-protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
1. Maintain room temperature within storage area at not less than 70 deg F (21 deg C) during the period plastic materials are stored.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install impact-resistant wall-protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 deg F (21 deg C) for not less than 72 hours before beginning installation and for the remainder of the construction period.

B. Field Measurements: Verify actual locations of walls, columns, and other construction contiguous with impact-resistant wall-protection units by field measurements before fabrication and indicate measurements on Shop Drawings.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of impact-resistant wall-protection units that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Structural failures.
   b. Deterioration of plastic and other materials beyond normal use.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MATERIALS

A. Stainless-Steel Sheet: ASTM A 240/A 240M.

B. Adhesive: Type recommended by manufacturer for use with material being adhered to substrate indicated.

2.3 CORNER GUARDS

A. Surface-Mounted, Metal Corner Guards: Fabricated from 1-piece, formed metal with formed edges; with turn to match wall condition.
1. Manufacturers:
   a. American Floor Products Co., Inc.
   b. ARDEN Architectural Specialties, Inc.
   c. Balco, Inc.
   d. Boston Retail Products.
   e. Construction Specialties, Inc.
   f. IPC Door and Wall Protection Systems; Division of InPro Corporation.
   g. Pawling Corporation.
2. Material: Stainless steel, Type 304.
   a. Thickness: Minimum 0.0781 inch (2.0 mm).
   b. Finish: Directional satin, No. 4.
3. Wing Size: Nominal 1-1/2 by 1-1/2 inches (38 by 38 mm).
4. Corner Radius: 1/8 inch (3 mm).
5. Mounting: Adhesive.

2.4 FABRICATION

A. Fabricate impact-resistant wall-protection units to comply with requirements indicated for design, dimensions, and member sizes, including thicknesses of components.

B. Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.

C. Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

2.5 METAL FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Remove tool and die marks and stretch lines or blend into finish.
2. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

B. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

C. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
   1. For impact-resistant wall-protection units attached with adhesive or foam tape, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Complete finishing operations, including painting, before installing impact-resistant wall-protection system components.

B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

A. General: Install impact-resistant wall-protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
   1. Install impact-resistant wall-protection units in locations and at mounting heights indicated on Drawings or, if not indicated, at heights indicated below:
      a. Corner Guards: from top of wall base to 48 inches above finished floor.
   2. Provide splices, mounting hardware, anchors, and other accessories required for a complete installation.
      a. Provide anchoring devices to withstand imposed loads.

3.4 CLEANING

A. Immediately after completion of installation, clean plastic covers and accessories using a standard, ammonia-based, household cleaning agent.

B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION

SECTION 10 28 00
TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Public-use washroom accessories.
2. Private-use bathroom accessories.
3. Under-lavatory guards.
4. Custodial accessories.

B. Related Requirements:
1. Section 09 30 13 "Ceramic Tiling" for ceramic toilet and bath accessories.

1.3 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required, to prevent delaying the Work.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Include electrical characteristics.
4. Product Data for Credit MR 4.0: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content.

B. Samples: Full size, for each exposed product and for each finish specified.
1. Approved full-size Samples will be returned and may be used in the Work.

C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
1. Identify locations using room designations indicated.
2. Identify accessories using designations indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For accessories to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 RESTROOM ACCESSORIES

A. Provide the following accessories where indicated on the drawings.

B. Source Limitations: Obtain public-use washroom accessories from single source from single manufacturer.

C. Toilet Tissue (Roll) Dispenser :
1. Basis of Design: Tork Dispenser Bath Tissue Twin Jumbo Roll. Item #SCA56TR
2. Description: Double-roll dispenser
3. Mounting: Surface mounted.
4. Operation: Noncontrol delivery with standard spindle.
5. Capacity: Designed for jumbo 9-inch-diameter tissue rolls.
6. Material: Plastic
7. Color: Smoke

D. Paper Towel Roll Dispenser:
1. Basis of Design: enMotion Touch-free Towel Dispenser. Item #GPT59462
2. Mounting: Wall Mounted.
3. Paper Towel Type: 10” Roll
4. Material: Plastic
5. Color: Smoke

E. Waste Receptacle:
1. Mounting: Semirecessed.
2. Minimum Capacity: 4 gal.
3. Material and Finish: Stainless steel, No. 4 finish (satin)
4. Liner: Reusable vinyl liner.
5. Lockset: Tumbler type for waste receptacle.

F. Liquid-Foam Soap Dispenser:
1. Basis of Design: Signatry TFX Dispenser. Item #GOJS2789-12
2. Description: Designed for dispensing soap in foam form.
3. Mounting: Vertically oriented, surface mounted.
4. Capacity: 40 oz. (1200 mL)

5. Materials: Plastic.
6. Color: Dove-Gray
7. Refill Indicator: Window type.

G. Grab Bar:
1. Mounting: Flanges with exposed fasteners.
2. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
   a. Finish: Smooth, No. 4 finish (satin).
3. Outside Diameter: 1-1/2 inches (38 mm).
4. Configuration and Length: As indicated on Drawings.

H. Sanitary Napkin Vendor:
1. Type: Sanitary napkin.
2. Mounting: Surface mounted.
3. Operation: No coin (free).
4. Exposed Material and Finish: Stainless steel, No. 4 finish (satin).
5. Lockset: Tumbler type.

I. Sanitary-Napkin Disposal Unit:
1. Mounting: Partition mounted, dual access
2. Door or Cover: Self-closing, disposal-opening cover.
3. Receptacle: Removable.
4. Material and Finish: Stainless steel, No. 4 finish (satin).

J. Mirror Unit:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. AJW Architectural Products.
   b. American Specialties, Inc.
   c. Bobrick Washroom Equipment, Inc.
   d. Bradley Corporation.
   e. Brey-Krause Manufacturing Co.
   f. GAMCO Specialty Accessories; a division of Bobrick.
   g. Tubular Specialties Manufacturing, Inc.

2. Frame: Stainless-steel angle, 0.05 inch (1.3 mm) thick or Stainless-steel channel.
   a. Corners: Manufacturer's standard.

3. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
   a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
   b. Wall bracket of galvanized steel equipped with concealed locking devices requiring a special tool to remove.
4. Size: As indicated on Drawings.

K. Odor Control Mist Dispenser
1. Basis of Design: Timemist Classic Dispenser. Item #AMR1047809
2. Description: Time released aerosol fragrance dispenser

3. Mounting: Wall Mounted
4. Time Release: every 15 minutes, 24 hours a day, for 30 days min.
5. Material: Plastic
6. Color: White

L. Hand Sanitizer Dispenser
1. Basis of Design: Purell TFX Touch-Free Hand Sanitizer Dispenser
2. Description: Sensor activated
3. Mounting: Wall Mounted
4. Capacity: 40 oz. (1200 mL)
5. Material: Plastic
6. Color: Dove Gray

M. Robe Hook:
1. Description: Double-prong unit.
2. Material and Finish: Stainless steel, No. 4 finish (satin).

N. Towel Bar:
1. Description: 3/4-inch- (19-mm-) round tube with circular end brackets.
2. Mounting: Flanges with exposed fasteners.
3. Length: 24 inches (610 mm).
4. Material and Finish: Stainless steel, No. 4 finish (satin).

2.3 CHILDCARE ACCESSORIES

A. Source Limitations: Obtain childcare accessories from single source from single manufacturer.

B. Diaper-Changing Station:
1. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap.
   a. Engineered to support minimum of 250-lb (113-kg) static load when opened.
2. Mounting: Surface mounted, with unit projecting not more than 4 inches (100 mm) from wall when closed.
3. Operation: By pneumatic shock-absorbing mechanism.
4. Material and Finish: HDPE in manufacturer's standard color.
5. Liner Dispenser: Built in.

2.4 UNDERLAVATORY GUARDS

A. Underlavatory Guard:
1. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
2. Material and Finish: Antimicrobial, molded plastic, white.

2.5 CUSTODIAL ACCESSORIES

A. Source Limitations: Obtain custodial accessories from single source from single manufacturer.

B. Utility Shelf:
   1. Description: With exposed edges turned down not less than 1/2 inch (13 mm) and supported by two triangular brackets welded to shelf underside.
   2. Size: 16 inches (406 mm) long by 6 inches (152 mm) deep.
   3. Material and Finish: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel, No. 4 finish (satin).

C. Mop and Broom Holder:
   1. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
   2. Length: 36 inches (914 mm)].
   3. Hooks: Four.
   4. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
   5. Material and Finish: Stainless steel, No. 4 finish (satin).
      a. Shelf: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel.
      b. Rod: Approximately 1/4-inch- (6-mm-) diameter stainless steel.

2.6 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch (0.8-mm) minimum nominal thickness unless otherwise indicated.

B. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch (0.9-mm) minimum nominal thickness.

C. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 (Z180) hot-dip zinc coating.

D. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.

E. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

F. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).

2.7 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Remove temporary labels and protective coatings.

C. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION

SECTION 10 44 00
FIRE-PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Portable fire extinguishers.
   2. Fire-protection cabinets for the following:
      a. Portable fire extinguishers.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire-protection cabinets.
   1. Fire Extinguishers: Include rating and classification.
   2. Fire-Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.

B. Maintenance Data: For fire extinguishers and fire-protection cabinets to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fire extinguishers and fire-protection cabinets through one source from a single manufacturer.

B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
   1. Provide fire extinguishers approved, listed, and labeled by FMG.

1.5 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

B. Stainless-Steel Sheet: ASTM A 666, Type 304.

C. Break Glass: Clear float glass, ASTM C 1036, Type I, Class 1, Quality q3, 1.5 mm thick, single strength.

D. Tempered Break Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 1.5 mm thick.

2.3 PORTABLE FIRE EXTINGUISHERS

A. Manufacturers:
   1. Amerex Corporation.
   2. Ansul Incorporated.
   3. Badger Fire Protection.
   4. Buckeye Fire Equipment Company.
   5. Fire End & Croker Corporation.
   6. General Fire Extinguisher Corporation.
   7. JL Industries, Inc.
   8. Kidde Fyrnetics.
   9. Larsen's Manufacturing Company.
   10. Modern Metal Products; Div. of Technico.
   11. Moon American.
   12. Potter Roemer; Div. of Smith Industries, Inc.
   13. Watrous; Div. of American Specialties, Inc.

B. General: Provide fire extinguishers of type, size, and capacity for each fire-protection cabinet indicated.
   1. Valves: Manufacturer's standard.
   2. Handles and Levers: Manufacturer's standard.
   3. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

C. Wet-Chemical Type: UL-rated 2-A:1-B:C:K, minimum **1.6-gal. (6-L)** nominal capacity, with potassium acetate, citrate or carbonate-based chemical in stainless-steel container; with pressure-indicating gage.

D. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 10-A:40-B:C, 6-lb (2.7-kg) nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.4 FIRE-PROTECTION CABINET (Fire Extinguisher Cabinet)

A. Manufacturers:
1. Fire End & Croker Corporation.
2. General Accessory Mfg. Co.
3. JL Industries, Inc.
4. Kidde Fyrnetics.
5. Larsen's Manufacturing Company.
6. Modern Metal Products; Div. of Technico.
7. Moon American.
8. Potter Roemer; Div. of Smith Industries, Inc.
9. Watrous; Div. of American Specialties, Inc.

B. Cabinet Type: Suitable for fire extinguisher.

C. Cabinet Construction: Nonrated.

D. Cabinet Material: Enameled-steel sheet.
1. Shelf: Same metal and finish as cabinet.

E. Semi-recessed Cabinet: Cabinet box partially recessed in walls of shallow depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
1. Square-Edge Trim: 1-1/4- to 1-1/2-inch (32- to 38-mm) backbend depth.
2. Rolled-Edge Trim: 4-inch (102-mm) backbend depth.

F. Cabinet Trim Material: Same material and finish as door.

G. Door Material: Steel sheet.

H. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
1. Provide projecting door pull and friction latch.
2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.

I. Accessories:
1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
1) Location: Applied to cabinet door.

2) Application Process: Silk-screened.
3) Lettering Color: Red.
4) Orientation: Horizontal.

J. Finishes:
1. Manufacturer's standard baked-enamel paint for the following:
a. Exterior of cabinet, door, and trim, except for those surfaces indicated to receive another finish.
b. Interior of cabinet and door.

2.5 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
1. Weld joints and grind smooth.
2. Construct fire-rated cabinets with double walls fabricated from 0.0428-inch- (1.1-mm-) thick, cold-rolled steel sheet lined with minimum 5/8-inch- (16-mm-) thick, fire-barrier material.
a. Provide factory-drilled mounting holes.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch (13 mm) thick.
2. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.6 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 STEEL FINISHES

A. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond using manufacturer's standard methods.

B. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.
   1. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free, universal primer, selected for resistance to normal atmospheric corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

C. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for cabinets to verify actual locations before cabinet installation.

B. Examine walls and partitions for suitable framing depth and blocking where semi-recessed cabinets will be installed.

C. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged units.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recesses for semi-recessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at locations and heights acceptable to authorities having jurisdiction.
   1. Provide not less than 8 quantity, but up to the maximum number as directed by the AHJ.

B. Fire-Protection Cabinets: Fasten fire-protection cabinets to structure, square and plumb.

C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection specialties are installed, unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet manufacturer.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 10 51 13
METAL LOCKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Knocked-down corridor lockers.
2. Locker benches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of metal locker.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker.

B. LEED Submittals:
1. Product Data for Credit MR 4.0: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content.
2. Product Data for Credit IEQ 4.4: For composite wood products used in lockers, documentation indicating that product contains no urea formaldehyde.

C. Shop Drawings: For metal lockers.
1. Include plans, elevations, sections, details, and attachments to other work.
2. Show locker trim and accessories.
3. Include locker identification system and numbering sequence.

D. Samples: For each color specified, in manufacturer's standard size.

E. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available.

F. Samples for Verification: For the following products, in manufacturer's standard size:
1. Lockers and equipment.
2. Locker benches.

G. Product Schedule: For lockers.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for their installation.

B. Deliver combination control charts to Owner by registered mail or overnight package service.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.

1.8 COORDINATION

A. Coordinate sizes and locations of wood bases for metal lockers.

B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures.
      b. Faulty operation of latches and other door hardware.
   2. Damage from deliberate destruction and vandalism is excluded.
   3. Warranty Period for Knocked-Down Metal Lockers: Two years from date of Substantial Completion.
   4. Warranty Period for Welded Metal Lockers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain metal lockers, and accessories from single source from single locker manufacturer.
   1. Obtain locks from single lock manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Accessibility Requirements: For lockers indicated to be accessible, comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC A117.1.

2.3 KNOCKED-DOWN CORRIDOR LOCKERS

A. Basis of Design:
   1. Republic Lockers: Quiet Corridor Locker

B. Doors: One piece; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.
   1. Doors less than 12 inches (305 mm) wide may be fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
   2. Doors for box lockers less than 15 inches (381 mm) wide may be fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
   3. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches (381 mm) wide; welded to inner face of doors.
   4. Stiffeners: Manufacturer's standard full-height stiffener fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet; welded to inner face of doors.
   5. Sound-Dampening Panels: Manufacturer's standard, designed to stiffen doors and reduce sound levels when doors are closed, of die-formed metal with full perimeter flange and sound-dampening material; welded to inner face of doors.
   6. Door Style: Unperforated panel. Vented panel as follows:
      a. Concealed Vents: Slotted perforations in top and bottom horizontal door return flanges.

C. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet with thicknesses as follows:
   1. Tops, Bottoms, and Intermediate Dividers: 0.024-inch (0.61-mm) nominal thickness, with single bend at sides.
   2. Backs and Sides: 0.024-inch (0.61-mm) nominal thickness, with full-height, double-flanged connections.
   3. Shelves: 0.024-inch (0.61-mm) nominal thickness, with double bend at front and single bend at sides and back.

D. Frames: Channel formed; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory

welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.

1. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.
2. Frame Vents: Fabricate face frames with vents.

E. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.

1. Hinges: Manufacturer's standard, steel, continuous or knuckle type.

F. Recessed Door Handle and Latch: Stainless-steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.

1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in key locks, or padlocks; positive automatic latching and prelocking.
    a. Latch Hooks: Equip doors 48 inches (1219 mm) and higher with three latch hooks and doors less than 48 inches (1219 mm) high with two latch hooks; fabricated from 0.105-inch (2.66-mm) nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.

G. Door Handle and Latch for Box Lockers: Stainless-steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.

H. Locks: Combination padlocks.

I. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch (9 mm) high.

J. Hooks: Manufacturer's standard ball-pointed type hooks, aluminum or steel; zinc plated.

K. Continuous Zee Base: Fabricated from manufacturer's standard thickness, but not less than 0.060-inch (1.52-mm) nominal-thickness steel sheet.

1. Height: 4 inches (102 mm).

L. Continuous Flat Tops: Fabricated from manufacturer's standard thickness, but not less than 0.036-inch (0.91-mm) nominal-thickness steel sheet.

M. Recess Trim: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

N. Filler Panels: Fabricated from manufacturer's standard thickness, but not less than 0.036-inch (0.91-mm) nominal-thickness steel sheet.

O. Boxed End Panels: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet.

P. Finished End Panels: Fabricated from 0.024-inch (0.61-mm) nominal-thickness steel sheet.

Q. Center Dividers: Fabricated from 0.024-inch (0.61-mm) nominal-thickness steel sheet.

R. Materials:
1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with A60 (ZF180) zinc-iron, alloy (galvannealed) coating designation.

S. Finish: Baked enamel or powder coat.
1. Color: As selected by Architect from manufacturer's full range.

2.4 LOCKS

A. Latches: Vertical-lift latches allowing use of individuals' personally-owned padlocks.

2.5 LOCKER BENCHES

A. Provide bench units with overall assembly height of 17-1/2 inches (445 mm).

B. Bench Tops: Manufacturer's standard one-piece units, with rounded corners and edges.
1. Size: Minimum 9-1/2 inches wide by 1-1/4 inches thick (241 mm wide by 32 mm thick) except provide minimum 20-inch- (508-mm-) wide tops where accessible benches are indicated.
2. Laminated clear hardwood with one coat of clear sealer on all surfaces and one coat of clear lacquer on top and sides.
a. Color: As selected by Architect from manufacturer's full range.

C. Fixed Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top and anchoring to floor, complete with fasteners and anchors, and as follows:
1. Tubular Steel: 1-1/4-inch- (32-mm-) diameter steel tubing, with 0.1265-inch- (3.2-mm-) thick steel flanges welded at top and base; with baked-enamel or zinc-plated finish; anchored with exposed fasteners.
a. Color: As indicated by manufacturer's designations.

D. Materials:
1. Stainless Steel: ASTM A 666, Type 304.
2. Steel Tube: ASTM A 500/A 500 M, cold rolled.

2.6 FABRICATION

A. Fabricate metal lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.
1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.

B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments. Factory weld frame members of each metal locker together to form a rigid, one-piece assembly.

C. Equipment: Provide each locker with an identification plate and the following equipment:
   1. Single-Tier Units: Shelf, one double-prong ceiling hook, and two single-prong wall hooks.
   2. Double-Tier Units: One double-prong ceiling hook and two single-prong wall hooks.

D. Knocked-Down Construction: Fabricate metal lockers using nuts, bolts, screws, or rivets for nominal assembly at Project site.

E. Accessible Lockers: Fabricate as follows:
   1. Locate bottom shelf no lower than 15 inches (381 mm) above the floor.
   2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches (1219 mm) above the floor.

F. Continuous Base: Formed into channel or zee profile for stiffness, and fabricated in lengths as long as practical to enclose base and base ends of metal lockers; finished to match lockers.

G. Continuous Sloping Tops: Fabricated in lengths as long as practical, without visible fasteners at splice locations; finished to match lockers.
   1. Sloping-top corner fillers, mitered.

H. Recess Trim: Fabricated with minimum 2-1/2-inch (64-mm) face width and in lengths as long as practical; finished to match lockers.

I. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.

J. Boxed End Panels: Fabricated with 1-inch- (25-mm-) wide edge dimension, and designed for concealing fasteners and holes at exposed ends of nonrecessed metal lockers; finished to match lockers.
   1. Provide one-piece panels for double-row (back-to-back) locker ends.

K. Finished End Panels: Designed for concealing unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.
   1. Provide one-piece panels for double-row (back-to-back) locker ends.

L. Center Dividers: Full-depth, vertical partitions between bottom and shelf; finished to match lockers.

2.7 ACCESSORIES

A. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.

B. Anchors: Material, type, and size required for secure anchorage to each substrate.

   1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls, and elsewhere as indicated, for corrosion resistance.
   2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install lockers level, plumb, and true; shim as required, using concealed shims.
1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches (910 mm) o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
2. Anchor single rows of metal lockers to walls near top and bottom of lockers.
3. Anchor back-to-back metal lockers to floor.

B. Knocked-Down Lockers: Assemble with standard fasteners, with no exposed fasteners on door faces or face frames.

C. Equipment:
1. Attach hooks with at least two fasteners.
2. Attach door locks on doors using security-type fasteners.
3. Identification Plates: Identify metal lockers with identification indicated on Drawings.
    a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
    b. Attach plates to upper shelf of each open-front metal locker, centered, with a least two aluminum rivets.

D. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
1. Attach recess trim to recessed metal lockers with concealed clips.
2. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
3. Attach sloping-top units to metal lockers, with closures at exposed ends.
4. Attach boxed end panels using concealed fasteners to conceal exposed ends of nonrecessed metal lockers.
5. Attach finished end panels using fasteners only at perimeter to conceal exposed ends of nonrecessed metal lockers.

3.3 ADJUSTING

A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.

3.4 PROTECTION

A. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.

B. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION

SECTION 10 75 27
PLAZA-MOUNTED FLAGPOLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes plaza-mounted flagpoles made from aluminum.

B. Owner-Furnished Material: Flags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, operating characteristics, fittings, accessories, and finishes for flagpoles.

B. Shop Drawings: For flagpoles.
   1. Include plans, elevations, details, and attachments to other work. Show general arrangement, jointing, fittings, accessories, grounding, anchoring, and support.
   2. Include details of plaza-mounted connections and mountings.

C. Samples for Verification: For each type of exposed finish, in manufacturer's standard sizes.

D. Delegated-Design Submittal: For flagpoles.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flagpoles to include in operation and maintenance manuals.

1.5 COORDINATION

A. Coordinate installation of anchorages for flagpoles. Furnish setting drawings, templates, and directions for installing anchorages that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Spiral wrap flagpoles with heavy paper and enclose in a hard fiber tube or other protective container.

B. Store products in manufacturer’s unopened packaging until ready for installation.

C. Keep flagpole and accessories covered and dry to prevent soiling or damage.

D. Handle with protective gloves to prevent unwanted distortion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain flagpoles as complete units, including fittings, accessories, bases, and anchorage devices, from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design flagpole assemblies.

B. Seismic Performance: Flagpole assemblies shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

C. Structural Performance: Flagpole assemblies, including anchorages and supports, shall withstand design loads indicated within limits and under conditions indicated.
   1. Wind Loads: Determine according to NAAMM FP 1001. Basic wind speed for Project location is as indicated.
   2. Base flagpole design on nylon or cotton flags of maximum standard size suitable for use with flagpole or flag size indicated, whichever is more stringent.

2.3 ALUMINUM FLAGPOLES

A. Aluminum Flagpoles: Entasis-tapered flagpoles fabricated from seamless extruded tubing complying with ASTM B 241/B 241M, Alloy 6063, with a minimum wall thickness of 3/16 inch (4.8 mm).

B. Exposed Height: 20 feet (9 m).

C. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:
   1. Fabricate shop and field joints without using fasteners, screw collars, or lead calking.
   2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.

D. Cast-Metal Shoe Base: Made from aluminum with same finish and color as flagpoles for anchor-bolt mounting; furnish with anchor bolts.
   1. Furnish connector to building's lightning protection system conductor.

E. Hinged Baseplate: Cast-metal tilting hinged base and anchor plate joined by permanently secured pivot rod. Furnish with stainless-steel screws for securing tilting base to anchor plate when not tilted; furnish with anchor bolts.
   1. Finish: Same as flagpole.
   2. Furnish aluminum base or aluminum flashing collar finished to match flagpole.
   3. Furnish connector to building's lightning protection system conductor.

2.4 FITTINGS

A. Finial Ball: Flush-seam ball, sized as indicated or, if not indicated, to match flagpole-butt diameter. Include integral LED down-lights, wired to permanent power and automatically controlled by photocell.
   1. 0.063-inch (1.6-mm) spun aluminum, finished to match flagpole.

B. Internal Halyard, Winch System: Manually operated winch with control-stop device and removable handle, stainless-steel cable halyard, and concealed revolving truck assembly with plastic-coated counterweight and sling. Furnish flush access door secured with cylinder lock. Finish truck assembly to match flagpole.
   1. Halyard Flag Snaps: Stainless-steel swivel snap hooks with neoprene or vinyl covers. Furnish two per halyard.

2.5 MISCELLANEOUS MATERIALS

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M.

B. Elastomeric Joint Sealant: Single-component nonsag urethane joint sealant complying with requirements in Section 07 92 00 "Joint Sealants."

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

2.6 ALUMINUM FINISHES

A. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   1. Color and Gloss: Match Architect's sample.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FLAGPOLE INSTALLATION

A. General: Install flagpoles where indicated and according to Shop Drawings and manufacturer's written instructions.

B. Baseplate: Install baseplate on washers placed over leveling nuts on bolts and adjust until flagpole is plumb. After flagpole is plumb, tighten retaining nuts and fill space under

baseplate solidly with nonshrink, nonmetallic grout. Finish exposed grout surfaces smooth and slope 45 degrees away from edges of baseplate.

C. Mounting Brackets and Bases: Anchor brackets and bases securely to structural support with fasteners as indicated on Shop Drawings.

END OF SECTION

DIVISION 11
EQUIPMENT

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SECTION 11 00 00
EQUIPMENT GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide all tools, supplies, materials, equipment, and all labor necessary for the furnishing, construction, installation, testing, and operation of all equipment and appurtenant Work, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all equipment specified and where referred to, except where otherwise indicated.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards: All equipment, products, and their installation shall be in accordance with the following standards, as applicable, and as indicated in each Section of these Specifications:

American Gear Manufacturers Association (AGMA).

American Society for Testing and Materials (ASTM).

American Public Health Association (APHA).

American National Standards Institute (ANSI).

American Society of Mechanical Engineers (ASME).

American Water Works Association (AWWA).

American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA).

Mechanical Power Transmission Association (MPTA).

American Welding Society (AWS).

National Fire Protection Association (NFPA).

Federal Specifications (FS).

National Electrical Manufacturers Association (NEMA).

Manufacturer's published recommendations and specifications.

General Industry Safety Orders (OSHA).

Rubber Manufacturers Association (RMA).

B. The following standards have been referred to in this Section of the Specifications:

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and Other Special Alloys
ANSI B46.1	Surface Texture
ANSI S12.6	Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors
ANSI/ASME B1.20.1	General Purpose Pipe Threads (Inch)
ANSI/ASME B31.1	Power Piping
ANSI/AWWA D100	Welded Steel Tanks for Water Storage
AWWA C206	Field Welding of Steel Water Pipe
ASTM A 48	Specification for Gray Iron Castings
ASTM A 108	Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings: The Contractor shall furnish complete shop drawings for all equipment specified in the various Sections, together with all piping, valves, and controls for review by the Engineer in accordance with Section 01 33 20 - Contractor Submittals.

B. Tools: The Contractor shall supply one complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of the equipment. All tools shall be of best quality hardened steel forgings with bright, finish wrench heads shall have work faces dressed to fit nuts. All tools shall be suitable for professional work and manufactured by a recognized supplier of professional tools such as Snap On, Crescent, Stanley, or equal. The set of tools shall be neatly mounted in a labeled tool box of suitable design provided with a hinged cover. For each microprocessor-based equipment system requiring a handhold device for configuration, furnish one handhold device.

C. Spare Parts: The Contractor shall obtain and submit from the manufacturer a list of suggested spare parts for each piece of equipment. After approval, Contractor shall furnish such spare parts suitably packaged, identified with the equipment number, and labeled. Contractor shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment. All spare parts are intended for use by the OWNER only, after expiration of the guaranty period.

D. Torsional Analysis: The Contractor shall submit to the Engineer a torsional and lateral vibration analysis of the following equipment, in accordance with Section 01 33 20 - Contractor Submittals. The analysis has to be performed by a specialist experienced in this type of Work and approved by the Engineer.
   1. All engine drives.
   2. All blowers and compressors with drives of 100 horsepower and over.
   3. All vertical pumps with universal joints and extended shafts.
   4. All other equipment where indicated.
   5. The torsional natural frequency of the drive train must be avoided by plus and minus 25 percent by any exciting frequency of the equipment, throughout the entire operating range.

E. Vibration Analysis: In the bid price the Contractor shall include at least two site visits of the above mentioned specialist, during construction and testing of the equipment, to analyze and measure the amount of equipment vibration and make his written recommendation for keeping the vibration at a safe limit.

F. Operation and Maintenance Manuals: Submit in accordance with Section 01 33 20 – Contractor Submittals.

1.4 QUALITY ASSURANCE

A. Inspection, Startup, and Field Adjustment: The Contractor shall demonstrate that all equipment meets the specified performance requirements. Contractor shall provide the services of an experienced, competent, and authorized service representative of the manufacturer of each item of major equipment who shall visit the site to perform the following tasks:
   1. Assist the Contractor in the installation of the equipment.
   2. To inspect, check, adjust if necessary and approve the equipment installation.
   3. To start-up and field-test the equipment for proper operation, efficiency, and capacity.
   4. To perform necessary field adjustments during the test period until the equipment installation and operation are satisfactory to the Engineer.
   5. To instruct the Owner's personnel in the operation and maintenance of the equipment. Instruction shall include step-by-step trouble shooting procedures with all necessary test equipment.

B. Costs: The costs of all inspection, startup, testing, adjustment, and instruction Work performed by said factory-trained representatives shall be borne by the Contractor. The Owner will pay for costs of power and water. When available, the Owner's operating personnel will provide assistance in the field testing.

C. Public Inspection: It shall be the responsibility of the Contractor to inform the local authorities, such as building and plumbing inspectors, Fire Marshall, OSHA inspectors, and others, to witness all required tests for piping, plumbing, fire protection systems, pressure vessels, and safety systems to obtain all required permits and certificates, and pay all fees.

D. Tolerances: Tolerances and clearances shall be as shown on the shop drawings and shall be closely adhered to. Machine Work shall in all cases be of high-grade workmanship and finish,

with due consideration to the special nature or function of the parts. Members without milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30 feet or less in length, and not greater than 1/8-inch for members over 30 feet in length.

E. Machine Finish: The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following finishes shall be used:
   1. Surface roughness not greater than 63 micro-inches shall be required for all surfaces in sliding contact.
   2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.
   3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.
   4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

F. Manufacturer's Experience: Unless otherwise directed by the ENGINEER, all equipment furnished shall have a record of at least 5 years of successful, trouble free operation in similar applications, from the same manufacturer.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. High Noise Level Location: The Contractor shall provide one personal hearing protection station, as indicated herein, at each high noise level location. Said locations are defined as follows:
   1. Outdoor Location: Any single equipment item or any group of equipment items that produce noise exceeding OSHA noise level requirements for a 2-hour exposure. Where such equipment is separated by a distance of more than 20 feet, measured between edges of footings, each group of equipment shall be provided with a separate hearing protection station.
   2. Indoor Location
      a. Any single equipment item, or any group of equipment items, located within a single room not normally occupied, that produces noise exceeding OSHA noise level requirements for a 2-hour exposure.
      b. Any single equipment item, or any group of equipment items, located within a single room normally occupied by workers, that produces noise exceeding OSHA noise level requirements for an 8-hour exposure.
   3. Personal Hearing Protection: The Contractor shall supply, in their original unopened packaging, three pairs of high attenuation hearing protectors. The ear protectors shall be capable of meeting the requirements of ANSI S12.6 and shall produce a noise level reduction of 25 dBA at a frequency of 500 Hz. The hearing protectors shall have fluid filled ear cushions and an adjustable, padded headband. The protectors shall be stored in a weatherproof, labeled, steel cabinet, furnished by the Contractor and mounted in an approved location near the noise protection station.

B. Service Factors: Service factors shall be applied in the selection or design of mechanical power transmission components. Unless otherwise indicated, the following load classifications shall apply in determining service factors:

Type of Equipment	Load Classification
Blower:	
Centrifugal or vane	Uniform
Lobe	Moderate Shock
Reciprocating Air Compressor:	
Multi-Cylinder	Moderate Shock
Single-Cylinder	Heavy Shock
Pump:	
Centrifugal or Rotary	Uniform
Reciprocating	Moderate Shock
Mixer:	
Constant Density	Uniform
Variable Density	Moderate Shock
Crane or Hoist	Moderate Shock

C. For service factors of electric motors, see Section 26 19 00 – Medium-Voltage Induction Motors. Where load classifications are not indicated, best modern practice shall be used.

D. Welding: Unless otherwise indicated, all welding shall conform to the following:
1. Latest revision of ANSI/AWWA D100.
2. Latest revision of AWWA C206.
3. All composite fabricated steel assemblies which are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent entrance of air or moisture.

E. All welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.

F. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All

sharp corners of material which is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

G. Protective Coating: All equipment shall be painted or coated in accordance with Section 09 90 01 – Protective Coatings, unless otherwise indicated. Nonferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

H. Protection of Equipment: All equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage by methods recommended by the manufacturer. All equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weathertight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers should be avoided, to prevent accumulation of condensate in gears and bearings.

I. Identification of Equipment Items: Each item of equipment shipped shall have a legible identifying mark corresponding to the equipment number indicated for the particular item.

J. Vibration Level: All equipment subject to vibration shall be provided with restrained spring-type vibration isolators or pads per manufacturer's written recommendations.

K. Shop Fabrication: Shop fabrication shall be performed in accordance with the Contract Documents and the Engineer-approved shop drawings.

2.2 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. Equipment Supports: All equipment supports, anchors, and restrainers shall be adequately designed for static, dynamic, wind, and seismic loads. The design horizontal seismic force shall be the greater of: that noted in the general structural notes or as required by the governing building code, or 10 percent of gravity. Submitted design calculations for equipment supports must bear the signature and seal of an Engineer registered in Utah.

B. Equipment Foundations: Equipment foundations shall be as per manufacturer's written recommendations. All mechanical equipment, tanks, and control cabinets shall be mounted on concrete bases as shown on standard structural details.

C. Shop Drawings: Shop drawings shall be submitted to the Engineer for review in accordance with the requirements of Section 01 33 20 – Contractor Submittals. Shop drawings will be considered incomplete unless clear, concise calculations are presented showing equipment anchorage forces and the capacities of the anchorage elements provided by the Contractor.

2.3 PIPE HANGERS, SUPPORTS, AND GUIDES

A. All pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment. Supports and hangers shall be in accordance with the requirements of Section 40 05 07 - Pipe Supports.

2.4 FLANGES AND PIPE THREADS

A. All flanges on equipment and appurtenances provided under this Section shall conform to ANSI B16.1, Class 125; or B16.5, Class 150, unless otherwise indicated. All pipe threads shall be in accordance with ANSI/ASME B1.20.1, and with requirements of Section 40 05 00 - Piping, General.

2.5 COUPLINGS

A. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to cushion shock loads. Where required for vertical shafts, 3-piece spacer couplings or universal type couplings for extended shafts shall be installed.

B. The CONTRACTOR shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.

C. Taper-lock bushings may be used to provide for easy installation and removal on shafts of various diameters.

D. Where universal type couplings are shown, they shall be of the needle bearing type construction, equipped with commercial type grease fittings.

2.6 SHAFTING

A. General: All shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. All shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.

B. Materials: Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as indicated unless furnished as part of an equipment assembly.
   1. Low carbon cold-rolled steel shafting shall conform to ASTM A 108, Grade 1018.
   2. Medium carbon cold-rolled shafting shall conform to ASTM A 108, Grade 1045.
   3. Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.

C. Differential Settlement: Where differential settlement between the driver and the driven equipment may be expected, a shaft of sufficient length with two sets of universal type couplings shall be provided.

2.7 2.7 BEARINGS

A. General: Bearings shall conform to the standards of the AFBMA.

B. To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and other important factors shall be considered in bearing selection.

C. All re-lubricatable type bearings shall be equipped with a hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.

D. All lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.

E. Bearing Life: Except where otherwise indicated, all bearings shall have a minimum L-10 life expectancy of 5 years or 20,000 hours, whichever occurs first. Where indicated, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	Design Life (years)*	L-10 Design Life (hours)*
8-hour shift	10	20,000
16-hour shift	10	40,000
Continuous	10	60,000
* = Design Life in years or L-10 Design Life in hours, whichever occurs first		

F. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as indicated, or as recommended in the published standards of the manufacturer if not indicated. Split-type housings may be used to facilitate installation, inspection, and disassembly.

G. Sleeve-type bearings shall have a Babbitt or bronze liner.

2.8 GEARS AND GEAR DRIVES

A. Unless otherwise indicated, gears shall be of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a minimum service factor of 1.7, a minimum L-10 bearing life of 60,000 hours and a minimum efficiency of 94 percent. Worm gears shall not be used, unless specifically approved by the Engineer.

B. All gear speed reducers or increases shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, arranged for easy reading.

C. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.

D. Material selections shall be left to the discretion of the manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have two positive seals to prevent oil leakage.

E. Oil level and drain location relative to the mounting arrangement shall be easily accessible. Oil coolers or heat exchangers with all required appurtenances shall be furnished when necessary.

F. Where gear drive input or output shafts have to connect to couplings or sprockets supplied by others, the Contractor shall have the gear drive manufacturer supply matching key taped to the shaft for shipment.

2.9 DRIVE CHAINS

A. Power drive chains shall be commercial type roller chains and meet ANSI Standards.

B. A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.

C. A minimum of one connecting or coupler link shall be provided with each length of roller chain.

D. Chain and attachments shall be of the manufacturer's best standard material and suitable for the process fluid.

2.10 SPROCKETS

A. General: Sprockets shall be used in conjunction with all chain drives and chain-type material handling equipment.

B. Materials: Unless otherwise indicated, materials shall be as follows:
   1. Sprockets with 25 teeth or less, normally used as a driver, shall be made of medium carbon steel in the 0.40 to 0.45 percent carbon range.
   2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.
   3. Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A 48, Class 30.

C. All sprockets shall be accurately machined to ANSI Standards. Sprockets shall have deep hardness penetration in tooth sections.

D. Finish bored sprockets shall be furnished complete with keyseat and set screws.

E. To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with taper-lock bushings as required.

F. Idler sprockets shall be furnished with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving. Steel collars with set screws may be provided in both sides of the hub.

2.11 V-BELT DRIVES

A. V-belts and sheaves shall be of the best commercial grade and shall conform to ANSI, MPTA, and RMA Standards.

B. Unless otherwise indicated, sheaves shall be machined from the finest quality gray cast iron.

C. All sheaves shall be statically balanced. In some applications where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm may be required to be of special materials and construction.

D. To facilitate installation and disassembly, sheaves shall be furnished complete with taper-lock or QD bushings as required.

E. Finish bored sheaves shall be furnished complete with keyseat and set screws.

F. Sliding motor bases shall be provided to adjust the tension of V-belts.

2.12 DRIVE GUARDS

A. All power transmission, prime movers, machines, shaft extensions, and moving machine parts shall be guarded to conform with the OSHA Safety and Health Standards (29CFR1910). The guards shall be constructed of minimum 10 gauge expanded, flattened steel with smooth edges and corners, galvanized after fabrication and securely fastened. Where required for lubrication or maintenance, guards shall have hinged and latched access doors.

2.13 FLEXIBLE CONNECTORS

A. General: Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems in accordance with Section 40 05 00 - Piping, General.

2.14 INSULATING CONNECTIONS

A. General: Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used in accordance with the requirements of the Section 40 05 00 - Piping, General.

2.15 GASKETS AND PACKINGS

A. Gaskets shall be in accordance with the requirements of Section 40 05 00 - Piping, General.

B. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane "Everseal," or equal.

C. Packing around rotating shafts (other than valve stems) shall be "O"-rings, stuffing boxes, or mechanical seals, as recommended by the manufacturer and approved by the ENGINEER, in accordance with Section 43 20 10 - Pumps, General.

2.16 NAMEPLATES

A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.17 SAFETY REQUIREMENTS

A. Where Work areas are located within a flammable or toxic gas environment, suitable gas detection, ventilating, and oxygen deficiency equipment shall be provided. Workers shall be equipped with approved breathing apparatus.

2.18 OVERLOAD PROTECTION

A. General: Unless otherwise indicated in individual equipment Sections, all equipment drives incorporating overload protection shall be provided with an overload protection device.

B. Mechanical Torque Monitoring System: The overload protection shall be a mechanical device to provide for reliable protection in the event of excessive overload. It shall be a ball detent type designed for long term repeatability and life. It shall be infinitely adjustable by a single adjusting nut. Once set it shall be tamperproof, and incorporate a torque monitoring and control system. It shall activate an alarm set for 85 percent, and a motor cutout switch set for 100 percent of maximum continuous running torque. A visual torque indication shall be provided and oriented so that it may be read from the walkway. The dial shall be calibrated from 0 to 100 percent of maximum continuous running torque. The design of the torque limiter should initiate the mechanical disengagement of the drive upon overload. Each unit shall be suitable for outdoor/corrosive environments with a protective finish, corrosion inhibiting lubricants and a stainless steel cover.

C. Electronic Torque Monitoring System:
   1. As an alternative to the mechanical system, the overload protection may be an Electronic Torque Monitoring Control System capable of displaying torque, rpm's, one level of overload, and two levels of overload of the drive system. It shall incorporate a time-delay for start-up and a voltage monitoring and compensation circuit for up to $\pm$15 percent variation.
   2. The overload device shall be housed in an enclosure with NEMA rating in accordance with the area designations of Section 16050 - Electrical General Provisions. A visual torque dial shall be provided and oriented so that it can be easily read from the walkway.
   3. The torque monitoring system shall be calibrated to: alarm and shut down the system in the event the torque drops to 50 percent of normal running; alarm at 85 percent of maximum continuous running torque and shut down the motor at maximum continuous running torque of the equipment. The system shall be calibrated at the factory of the equipment manufacturer and it shall be capable of monitoring twice the maximum continuous running torque of the equipment.

D. Manufacturers, or Equal
   1. American Autogard Corporation;
   2. Ferguson Machine Company.

PART 3 - EXECUTION

3.1 COUPLINGS

A. The Contractor shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application; installation shall be per equipment manufacturer's printed recommendations.

3.2 INSULATING CONNECTIONS

A. All insulating connections shall be installed in accordance with the manufacturer's printed instructions.

3.3 PIPE HANGERS, SUPPORTS, AND GUIDES

A. Hangers, supports, seismic bracing and guides shall be spaced in accordance with ANSI/ASME B.31.1 standard, and with tables in Section 40 05 07 - Pipe Supports.

3.4 PACKAGED EQUIPMENT

A. When any system is furnished as pre-packaged equipment, the Contractor shall coordinate with subcontractors all necessary space and structural requirements, clearances, utility connections, signals, and outputs.

B. If the packaged system has any additional features (for example, safety interlocks), other than indicated, the Contractor shall coordinate such features with the Engineer and furnish all material and labor necessary for a complete installation as required by the manufacturer, at no additional cost to the Owner.

END OF SECTION

SECTION 11 32 00
KITCHEN EQUIPMENT

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide kitchen appliances and appurtenant Work, complete and operable, in accordance with the Contract Documents.

B. Mechanical and electrical designs are based on products of the named manufacturer. If the Contractor proposes and the Engineer accepts products from other manufacturers, the Contractor shall be responsible for providing and paying for modifications or capacity increases to mechanical, plumbing, or electrical systems to accommodate such products.

C. Prior to proceeding with installation of any changed mechanical or electrical Work, submit detailed drawings for review, showing the exact scope of changed Work that is required.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. All Work shall conform to or exceed the requirements of the Building Code.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 20 - Contractor Submittals.

B. Manufacturer's Information: The Contractor shall submit for each item of kitchen equipment the following: manufacturers' printed recommendation, installation instructions, specifications, operation manuals, engineering drawings, electrical drawings, plumbing drawings, and mechanical drawing, sales literature, and material and color samples.

1.4 QUALITY ASSURANCE

A. Warranty: The Contractor shall furnish all the equipment manufacturer’s standard warranties which run longer than the one year correction of defects period.

PART 2 - PRODUCTS

2.1 GENERAL

A. Model names and numbers of components and assemblies herein are products of Whirlpool Corporation. Such reference is not intended to limit competition, but rather to establish minimum standards for kind, quality, and function. Products from other manufacturers may be considered in accordance with Section 01 25 10 - Products, Materials, Equipment, and Substitutions.

2.2 DISHWASHER

A. Provide Whirlpool "Gold Tall Tub, Energy Star" Dishwasher, Model GU1500XTLQ, in the Kitchen. Unit shall be capable of 5 separate cycles, and a total of 30 cycle and option combinations. Power supply shall be 120 volt, 60 Hz., 20 amp separate circuit. Unit shall be connected to a 1/2-inch hot water supply and be capable of withstanding 120 degrees F temperature at 120 psi water pressure. Color will be as selected by the ENGINEER.

B. Contractor shall provide water/drain connections for water and drain service.

2.3 REFRIGERATOR

A. Provide Whirlpool "21.6 Cu. Ft. Freezer on the Top, Energy Star" Refrigerator, 21.6 cubic foot refrigerator/freezer with built-in ice maker, in the Kitchen. Power supply shall be 115 volt, 60 Hz., 15 amp circuit. Unit shall be UL listed with a 3-wire cord and 3-prong grounded plug. Unit shall be provided with 1/4-inch cold water supply with local control valve. Color will be selected as by the ENGINEER.

B. Contractor shall provide water connection and valve for ice maker hookup.

2.4 MICROWAVE/HOOD

A. Provide Whirlpool Microwave Oven/Hood Combination, 1.7 cu. ft. capacity, built-in unit in the Kitchen. Maximum heating capacity shall be 1000 watts, and unit shall be equipped with removable glass turntable. Recirculating hood. Power supply shall be 120 volt, 60 Hz., on a separate 20-amp circuit. Unit shall be UL listed and shall be provided with 3-wire cord and 3-prong grounded plug. Color will be as selected by the Engineer.

2.5 OVEN/RANGE

A. Provide Whirlpool Electric Range single oven, 5.0 cu. ft. capacity – Model WFC150M0JS, built-in unit in the Kitchen. Unit shall be provided with four separate coil elements with infinite heat controls, within ceramic-glass cooking surface. Power supply shall be three- or four-wire, single phase 240 volts, 60 Hz, 50 ampere. Unit shall be UL listed. Color will be as selected by the Engineer.

2.6 OTHER APPLIANCES

A. OWNER to select various small countertop appliances as needed, purchased under the contingency allowance bid item.

PART 3 - EXECUTION

3.1 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Equipment, Materials, and Products: Manufactured equipment, materials and products shall be delivered in original unbroken packages, containers, or bundles bearing the name of the manufacturer and product model name and numbers.

B. Storage: Equipment, materials, and products shall be carefully stored in an area which is protected from the deleterious elements in a manner recommended by the equipment manufacturer, to prevent damage to the equipment, materials, and product, and marring of the finishes.

C. Where necessary or appropriate, special items of equipment herein shall be installed by manufacturer authorized, factory-trained mechanics who are thoroughly familiar with all phases of operation and installation or the equipment.

3.2 COORDINATION WITH ELECTRICAL DRAWINGS AND DIVISION 16

A. Connection Information:
   1. As required by manufacturer.

3.3 SITE CONDITIONS

A. Kitchen appliances shall not be delivered to the Site nor installed until the building is fully enclosed, secured, sufficient heat is provided, dust generating activities have terminated, and overhead mechanical and electrical Work is completed, tested, and approved.

B. Wet Work such as plastering and grouting in the general vicinity shall be completed and cured prior to installation. Final wall finishes, millwork, and casework shall be at an appropriate stage of completion prior to installation.

C. Building environmental systems shall be operational prior to installation and shall be maintained in operation during and after the installation.

3.4 INSTALLATION

A. Kitchen appliances shall be assembled, fabricated, and installed in accordance with the Shop Drawings, and manufacturer's installation instructions and recommendations.

B. Appliances shall be installed in locations indicated. If indicated locations are not possible, seek and obtain direction from the Engineer before proceeding.

C. Appliances shall be installed level, plumb, and true, securely fastened and at the correct height.

D. Plumbing shall be piped and connected per Section 22 00 00 - Plumbing. All plumbing connections are not necessarily shown in the Drawings. Contractor shall provide as needed for fully operable appliances.

E. Mechanical equipment and systems shall be installed and connected as required and indicated within Section 23 00 00 – General Mechanical Requirements.

F. Electrical equipment and systems shall be wired and connected per Division 26, Electrical.

G. Any damaged finishes shall be restored to new condition.

H. Appliances shall be thoroughly cleaned, tested, and operated to confirm proper and workmanlike installation and operation. Installer or designated manufacturer's representative, shall thoroughly demonstrate the operation, controls and features of each appliance to the satisfaction of the Engineer and the Owner.

I. Protect appliances as required to ensure satisfactory operation and appearance at completion of project.

3.5 WORKMANSHIP

A. The finished installation shall be free from damage, flaws, blemishes or other defects detrimental to appearance; have doors and trim in alignment with adjacent surfaces, and be uniform in plane.

END OF SECTION

SECTION 11 53 00
LABORATORY EQUIPMENT

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish and install in locations and configurations indicated on the Drawings, all laboratory and miscellaneous equipment and appliances specified herein and all appurtenant Work complete. The Contractor shall coordinate all of the Work hereunder with the related Work specified in other Sections, all in accordance with the requirements of the Contract Documents.

B. The requirements of Section 12 35 53 – Metal Laboratory Casework apply to this section.

1.2 REFERENCE STANDARDS

A. Without limiting the generality of other requirements of the Specifications, all Work specified herein shall conform to or exceed the requirements of the Building Code and the applicable requirements of the following documents to the extent that the provisions of such documents apply and are not in conflict with the requirements of this Section:

NIH03-112C	National Institute of Health Specification
NFPA-45	Standard on Fire Protection for Laboratories Using Chemicals by National Fire Protection Association

American Society for Testing and Materials (ASTM)

Federal Specifications (FS)

Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)

Occupational Safety and Health Administration (OSHA)

Underwriters Laboratory (UL)

Environmental Protection Agency (EPA)

B. Manufacturer's Standards: In addition to the standards listed above, the laboratory equipment and products and their installation shall be in accordance with the manufacturer's published recommendations, instructions and specifications.

1.3 CONTRACTOR SUBMITTALS

A. General: All submittals shall be in accordance with the requirements of ASHRAE Standard 110.1995 and in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop Drawings: Where laboratory equipment products or any other Work of this Section are required to be built-in or otherwise integrated into the Work of other trades, the Contractor shall submit shop drawings which clearly define processes, procedures, materials, clearances and any other relevant aspect of such incorporation.

C. Samples: The Contractor shall submit to the Engineer for approval, samples of all materials, colors, and fabricated items proposed for use on the Work when requested within this section of Work. The samples shall be clearly marked to show the manufacturer's name and product identification. All sample submittals shall conform to the requirements for "Samples" in Section 01 33 20 - Contractor Submittals.

D. Manufacturer's Information: The manufacturer's specifications, literature and published installation and maintenance instructions for each product shall be submitted to the Engineer. The Contractor shall submit for each item of laboratory equipment, the following: manufacturers' printed recommendations; installation instructions; specifications; operation manuals; engineering drawings, including shop drawings, electrical drawings, plumbing drawings, and mechanical drawings; sales literature; material and color samples; statements of qualifications; lists of purchasers of similar units; and training materials as applicable.

E. Certificates: The Contractor shall submit to the Engineer, certificates from an independent testing laboratory certifying that the equipment submitted meets all the requirements of the ASTM and/or Federal Specifications cited.

F. Warranties: The Contractor shall furnish copies of the manufacturer's warranties covering the items specified within this Section.

1.4 PRODUCT DELIVERY, STORAGE, AND MATERIALS

A. Delivery of Equipment, Materials, and Products: Manufactured equipment, materials and products shall be delivered in original unbroken packages, containers, or bundles bearing the name of the manufacturer and product model name and numbers.

B. Storage: All equipment, materials, and products shall be carefully stored in an area which is protected from the deleterious elements in a manner recommended by the equipment manufacturer, to prevent damage to the equipment, materials, and product, and marring of the finishes.

PART 2 - PRODUCTS

2.1 GENERAL

A. Each type of laboratory equipment item specified herein or shown on the Drawings shall be the product of one manufacturer who specializes in production of these items.

B. Electrical laboratory equipment shall be UL tested or approved when specified.

C. Unless specified otherwise, the laboratory equipment shall be completely fabricated and assembled products with all piping, wiring, electrical, valves, cabinets, frames, supports,

ducts, fasteners, anchor, baskets, holders, etc., to provide the product specified complete and ready for operation.

D. All laboratory equipment shall meet or exceed requirements of *Standard Methods for Examination of Water and Wastewater*.

2.2 LABORATORY FIXTURES

A. Fixtures: Service fittings shall be laboratory-grade and water faucets and valve bodies shall be cast bronze with a minimum copper content of 85 percent. Fittings shall be epoxy powder coated. Color shall be as selected by the ENGINEER.

B. Serrated hose connectors with long taper end with ten-serrations shall be provided on all service fittings.

C. Valves for water shall be furnished with removable and replaceable parts subject to wear. Valves for gases shall be furnished with a floating steel cone and replaceable stainless steel seat.

D. Laboratory sink faucets (wall mounted) shall be of mixing type, all epoxy powder coated, with vacuum breaker, 6-inch swing spout, and ADA-compliant lever-type handles with color indicators for hot and cold water.

E. Laboratory sink faucets (ledge mounted) shall be of mixing type, epoxy powder coated, with vacuum breaker, 6-inch swing spout, and ADA-compliant lever-type handles with color indicators for hot and cold water.

F. Laboratory sink faucets at cup sinks not in fume hoods shall be ledge mounted, all epoxy powder coated, with vacuum breaker, 6-inch swing spout, ADA-compliant lever-type handle with color indicator for cold water.

G. Demineralized (deionized) water faucets (wall mounted) shall be manufactured of Schedule 80 PVC and be designed for use with demineralized water. Demineralized faucets shall be provided and be equipped with gooseneck spouts and ten-serration hose connections, with black polypropylene ADA-compliant lever-type handle with DI index.

H. Demineralized (deionized) water faucets (ledge mounted) shall be manufactured of Schedule 80 PVC and be designed for use with demineralized water. Demineralized faucets shall be provided and be equipped with gooseneck spouts and ten-serration hose connections, with black polypropylene ADA-compliant lever-type handle with DI index.

I. Faucets shall be as manufactured by Chicago Faucet, T&S Brass and Bronze Works, or approved equal.

2.3 LABORATORY FUME HOODS (NOT USED)

2.4 FULL SIZE LABORATORY REFRIGERATOR

A. Provide one (1) full size laboratory refrigerator. Unit shall be 23 cu. ft. capacity designed to operate in the 1 to 8 Deg. C temperature range. Each unit shall be furnished with hermetically

sealed compressor and automatic-defrost system using an automatic condensate removal technique that eliminates the need for drain lines. Refrigerator shall have stainless steel interiors, 1 self-closing triple-pane sliding glass door, door locks, fluorescent lighting, key-activated on/off power switch, and white epoxy-coated steel wire adjustable shelves.

1. Compressor: 1/3 hp, bottom mounted
2. Refrigerant: CFC-free R134A
3. Condenser Type: Fin and tube
4. Dimensions: Exterior 34"L x 26"W x 84-1/2"H
5. Electrical Requirements: 115V, 60 Hz, 13 Amps.

B. Laboratory refrigerator shall be "Isotemp Plus Chromotography Refrigerator, Model No. 13-986-134" as manufactured by Fisher Scientific; "Chromotography Refrigerator, Catalog No. 55702-480, with Electronic Temperature Control, Catalog No. 55702-534" as manufactured by VRW Scientific Products; or approved equal.

2.5 GLASS WASH

A. Provide one undercounter, deionized water rinse, glass washer/dryer system where indicated on the Drawings. The washer shall be Labconco Corp., Undercounter Flask Scrubber Model No. 4595600, or equal.

B. The glass washer/dryer system shall operate on 115 volts, 60 Hz AC power. The washer's electrical work shall be properly wired and ground for maximum safety. Utility connections shall include electricity, hot water, deionized/filtered water, and drain line. Glass washer shall include the following features:

1. Interior and front door of stainless steel construction.
2. Fiberglass insulation and adhesive acoustical coating surrounding the tank.
3. Control panel featuring push button timer for at least six different wash cycles with indicator lights and a cancel drain machine stop.
4. A 750-watt (minimum) sump heater and a 700-watt (minimum) in-line heater for a total drying capacity of 1,450 watts (minimum).
5. Filtered water pump and piping.
6. Water heater capable of producing 1,850 Deg F. rinse water.

C. Provide concrete anchorage system and all other items required for complete installation.

D. Provide water/drain connections required for complete installation.

2.6 ACCESSORIES

1. Drying Rack: The Contractor shall furnish and install modified epoxy resin pegboards, 24-inches wide by 30-inches high, with 21 polypropylene pegs minimum, wall mounted with purpose-designed wall brackets and/or island mounted with finished backs and custom brackets for box curb or countertop attachment. All pegboards shall have an integral stainless steel drip trough with hose drain.
    a. Pegboards shall be as manufactured by Kewaunee Manufacturing Company; Fisher Hamilton Industries; or approved equal.
    b. Laboratory Cylinder Wall Supports: The cylinder wall supports shall be strap or chain as provided by VWR Scientific #60142-003; or equal. The supports

shall hold cylinders, 4 ½-inches to 14-inches in diameter, in an upright position.

c. Lab cylinder wall supports shall be provided at Deionized (DI) water.

2. Automatic Pipette Washer: Provide one HDPE pipe washer system including washer/rinser, one pipette basket, and one soaking jar. The unit shall be designed to hold pipettes up to 24 inches long, include inlet/outlet tubing and operate at cycle speeds or 1.5 to 12 liters per minute without "siphon stall." The unit shall be Nalgene, Or Equal. execution

2.7 OTHER EQUIPMENT

A. OWNER to select various lab equipment, supplies, and appliances as needed, purchased under the contingency allowance bid item.

2.8 GENERAL

A. All laboratory equipment and related equipment items shall be installed in accordance with manufacturer's written instructions and/or recommendations for the specific applications and job conditions, unless more stringent requirements are indicated elsewhere.

B. Where necessary or appropriate, special items of laboratory equipment shall be installed by manufacturer authorized, factory-trained mechanics who are thoroughly familiar with all phases of operation and installation or the equipment.

C. Equipment Furnished by Owner and Installed by Contractor: Installation of equipment furnished by Owner and installed by the Contractor shall be in accordance with manufacturer's written instructions and/or recommendations for the specific applications and job conditions, unless more stringent requirements are indicated elsewhere.

2.9 COORDINATION WITH MECHANICAL DRAWINGS AND DIVISION 15

A. Contractor shall be responsible for coordination with Mechanical Drawings and Division 15 of Specifications for mechanical equipment and ductwork related to items of equipment specified under this Section. Full responsibility shall be assumed for the following items of Work:

1. Review of Mechanical Drawings and Specifications to verify that related equipment and ductwork sizes provided are adequate and compatible with the equipment specified and with any substitute equipment the Contractor proposes to submit for approval.
2. Prior to proceeding with installation of any additional mechanical Work, the Contractor shall submit detailed drawings for review, indicating the exact scope of additional mechanical Work that may be required.

2.10 COORDINATION WITH ELECTRICAL DRAWINGS AND DIVISION 16

A. Contractor shall be responsible for coordination with Electrical Drawings and Division 16 of Specifications for service voltage, power feed, control and interlock wiring for equipment specified under this Section. Full responsibility shall be assumed for the following items of WORK:

1. Review of Electrical Drawings and Specifications to verify that electrical services provided are adequate and compatible with the equipment specified and with any substitute equipment the Contractor proposes to submit for approval.
2. Prior to proceeding with installation of any additional electrical Work, Contractor shall submit detailed drawings for review, indicating the exact scope of additional electrical WORK that may be required.

2.11 INSPECTION

A. The Contractor's installer shall thoroughly examine all substrates on which the specified items of Laboratory Equipment will be installed and conditions under which Work of this Section is to be undertaken. The Contractor's installers shall coordinate and verify that locations and surfaces to receive equipment are satisfactory for their installation, and comply with the Specifications. The Contractor and Engineer shall be notified in writing of conditions detrimental to proper, timely and successful completion of the installation.

B. Installer shall not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

C. Commencing Work shall be construed as installer's acceptance of substrates, surfaces and conditions within any particular area as satisfactory to the successful completion of the installation.

2.12 SCHEDULING AND COORDINATION

A. Contractor shall coordinate the timely sequencing and installation of related mechanical, electrical and structural accommodations necessary to the proper installation and functioning of each item of Laboratory Equipment.

B. Contractor shall coordinate affected trades where necessary to secure items of equipment to finished surfaces.

2.13 SITE CONDITIONS

A. Laboratory equipment shall not be installed until the building is fully secured, enclosed, sufficient heat is provided, dust-generating activities have terminated and overhead mechanical and electrical Work is complete, tested and approved.

B. All wet Work such as plastering and grouting in the general vicinity shall be completed and cured prior to commencement of installation. All final wall finishes, millwork and casework shall be at an appropriate stage of completion prior to installation.

C. Building environmental systems shall be operational prior to the installation, and maintained in operation during and after the installation.

2.14 INSTALLATION

A. The laboratory equipment shall be assembled, fabricated and installed in accordance with accepted shop drawings, and manufacturer's installation instructions and recommendations.

B. Equipment shall be installed in locations shown on the Drawings. If indicated locations are not possible, installer shall seek and obtain direction from the Engineer before proceeding.

C. All equipment shall be installed level, plumb, and true, securely fastened and at the correct height.

D. Plumbing shall be piped and connected per manufacturer's instructions and per Section 22 00 00 - Plumbing and Piping. All plumbing connections are not necessarily shown in the Drawings. Contractor shall provide as needed for fully operable appliances.

E. All mechanical equipment, products, and items shall be installed and connected as required and/or specified within Section 23 00 00 – General Mechanical Requirements.

F. All electrical equipment and items shall be coordinated, wired and connected per manufacturer's instructions and per Division 26, Electrical. All electrical Work shall meet or exceed the requirements of the governing codes.

G. Any damaged finishes shall be restored to new condition.

H. Items of equipment shall be thoroughly tested and 'run-in' to confirm proper and workmanlike installation and operation.

I. Protection shall be provided as required to ensure satisfactory operation and appearance at completion of project.

2.15 WORKMANSHIP

A. The finished installation shall be free from damage, flaws, blemishes or other defects detrimental to appearance; have doors and trim in alignment with adjacent surfaces and be uniform in plane.

B. Installer or designated manufacturer's representative shall thoroughly demonstrate the operation, controls and features of each item of equipment, to the complete satisfaction of the Engineer and the Owner.

END OF SECTION

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DIVISION 12
FURNISHINGS

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SECTION 12 24 13
ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Manually operated roller shades with single rollers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Product test reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
   1. Chain-Retainer Type: Clip, jamb mount.
   2. Spring Lift-Assist Mechanisms: Provide for shadebands that weigh more than 10 lb (4.5 kg) or for shades as recommended by manufacturer, whichever criterion is more stringent.

B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
   1. Roller Drive-End Location: Right side of interior face of shade.
   2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.

C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.

E. Shadebands:
   1. Shadeband Material: Light-filtering fabric.
   2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
      a. Type: Enclosed in sealed pocket of shadeband material.
      b. Color and Finish: As selected by Architect from manufacturer's full range.

F. Installation Accessories:
   1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
   2. Endcap Covers: To cover exposed endcaps.
   3. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 SHADEBAND MATERIALS

A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
   1. Source: Roller shade manufacturer.
   2. Type: Woven PVC-coated fiberglass and PVC-coated polyester.
   3. Weave: Mesh or Basketweave.
   4. Thickness: Manufacturer’s standard for commercial applications.
   5. Weight: Manufacturer’s standard for commercial applications.
   6. Roll Width: Manufacturer’s standard, but not less than individual window opening width.
   7. Openness Factor: 1-3 percent.
   8. Color: As selected by Architect from manufacturer's full range.

2.4 ROLLER SHADE FABRICATION

A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):

1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch (6 mm) per side or 1/2-inch (13-mm) total, plus or minus 1/8 inch (3.1 mm). Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch (6 mm), plus or minus 1/8 inch (3.1 mm).

C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:

1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

PART 3 - EXECUTION

3.1 ROLLER SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.

B. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

C. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.

D. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

END OF SECTION

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SECTION 12 36 53
LABORATORY WORKSURFACES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Epoxy resin worksurfaces, sinks, and accessories.
2. Setting materials.

B. Related Sections:
1. Div. 01: Administrative, procedural, and temporary work requirements.
2. Div. 05 - Metal Fabrications.
3. Div. 07 - Joint sealers.
4. Div. 06 – Plastic Laminate Cabinets

1.2 REFERENCES

A. ASTM International (ASTM):
1. D570 - Standard Test Method for Water Absorption of Plastics.
2. D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
3. D648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Oad in edgewise Position.
4. D695 - Standard Test Method for Compressive Properties of Rigid Plastics.
5. D696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between 30^0 C and 30^0 C With a Vitreous Silica Dilatometer.
6. D785 - Standard Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials.
7. D790 - Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
8. D792 - Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
9. D3801 - Standard Test Method for Measuring the Comparative Burning Characteristics of Solid Plastics in a Vertical Position.
10. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. GREENGUARD Environmental Institute (GREENGUARD):
1. Indoor Air Quality Certification Program.
2. Children and Schools Certification Program.

C. International Organization for Standardization (ISO) 9001 - Quality Management Systems - Requirements.

D. NSF International / American National Standards Institute (NSF/ANSI) - 51 - Food Equipment Materials.

E. Scientific Certification Systems (SCS) - Recycled Content Certifications.

F. Scientific Equipment and Furniture Association (SEFA) 3 - Work Surfaces.

1.3 SUBMITTALS

A. Submittals for Review:
   1. Shop Drawings:
      a. Submit plan, section, elevation and perspective drawings necessary to describe and convey layout, profiles, and product components, including edge conditions, joints, fitting and fixture locations, anchorage, accessories, and finish colors.
      b. Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on Shop Drawings.
      c. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.
   2. Product Data: Manufacturer's data sheets on each product to be used, including:
      a. Preparation instructions and recommendations.
      b. Storage and handling requirements and recommendations.
      c. Installation methods.
   3. Samples:
      a. Selection samples: For each finish product specified, submit complete set of color chips representing manufacturer's full range of standard colors.
      b. Verification samples: For each finish product specified, submit samples representing actual product color; supplied product color and gloss may vary slightly from supplied samples.

B. Quality Control Submittals:
   1. Test Reports: Certified test reports or recognized evaluation reports showing compliance with specified performance characteristics and physical properties.

C. Closeout Submittals:
   1. Maintenance Data:
      a. Provide maintenance, cleaning, and life cycle information.
      b. Include recommended cleaning materials and procedures, and list of materials detrimental to epoxy resin.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Primary products furnished by single manufacturer with minimum 10 years documented experience in work of this Section.
   2. Products manufactured in ISO 9001 certified facility.

B. Installer Qualifications: Minimum 5 years documented experience in work of this Section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery:
   1. Use pallets larger than sheets during transportation.
   2. Package materials to prevent damage during shipping and handling.

B. Storage:
   1. Store products in enclosed area protected from ultraviolet.
   2. Store products in manufacturer's unopened packaging until ready for installation.
   3. Store panels using protective dividers to avoid damage to surfaces.
   4. For horizontal storage, store sheets on pallets of equal or greater size than sheets with protective layer between pallet and sheet and on top of uppermost sheet.
   5. Do not store sheets or fabricated panels vertically.

C. Handling:
   1. If protective film is provided, do not remove until panel has been installed.
   2. Handle sheets to prevent damage.
   3. Remove stickers immediately after installation.

1.6 PROJECT CONDITIONS

A. Do not install products under environmental conditions outside manufacturer's limits.

B. Avoid direct exposure of products to sunlight.

C. Do not use worksurfaces as bench, ladder, or seating.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-design products are by Durcon, Incorporated, 206 Allison Drive, Taylor, TX 76574, 512-595-8000, www.durcon.com.

B. Substitutions: Demonstrate performance characteristics equal to or exceeding those of the basis-of-design materials.

2.2 MATERIALS

A. Solid Epoxy Resin:
   1. Sheets cast from modified epoxy resin and non-asbestos inert fillers; compounded mixture cured and thermoset specifically from formulation to provide exceptional physical and chemical resistance required in medium to heavy duty laboratory environments.

2.3 ACCESSORIES

A. Provide solid epoxy resin where indicated.

B. Installation Materials: Manufacturer's joint adhesive, panel adhesive, and sealants as required to suit project conditions.

2.4 FABRICATION

A. Fabricated tops and accessories in accordance with manufacturer's recommendations, approved Shop Drawings, and SEFA 3.

B. Epoxy Resin Worksurfaces:
   1. Thickness:
      a. 1 inch (25 mm) unless otherwise indicated.
      b. Check each sheet at factory for required thickness.
      c. Maximum variation in thickness: plus or minus 1/16 inch (1.6 mm) from corner to corner.
   2. Warpage:
      a. Inspect tops for warpage prior to fabrication by placing on true flat surface.
      b. Maximum allowable warpage: 1/16 inch (1.5 mm) in 36 inch (900 mm) span or 3/16 inch (4.5 mm) in 96 inch (2400 mm) span.
   3. Fabrication:
      a. Shop fabricate in longest practical lengths.
      b. Bond joints with highly chemical resistant cement with properties and color similar to base material.
      c. Provide 1/8 inch (3 mm) drip groove at underside of exposed edges, set back 1/2 inch (13 mm) from face.
      d. Finish exposed edges.
   4. Fabricate tops flat.
   5. Edge treatment: Standard 1/8 inch (2 mm) chamfered edge.
   6. Corner treatment: exposed corners shall be eased slightly for safety.
   7. Back and end splashes:
      a. Supplied loose for field installation.
      b. Same material and thickness as worksurfaces.
      c. 4 inches high unless otherwise indicated.

d. Top-mounted end splash where worksurfaces abut adjacent construction and locations indicated on Drawings.

8. Joints: Maximum 1/8 inch (2 mm), bonded with epoxy grout.
9. Make joints between two benches level.
10. Locate joints away from sinks and over or near supports.
11. Sink cutouts: Routed for sink specified in plumbing spec/schedules. Coordinate with plumbing schedules and specifications.
12. Allowable tolerances:
    a. Square: Plus or minus 1/64 inch (0.4 mm) for each 12 inches (300 mm) of length.
    b. Location of cutouts and drilled openings: Plus or minus 1/8 inch (3 mm) of design dimension.
    c. Size of cutouts and drilled openings: Plus 1/8 inch (3 mm) or minus 0 inches (0 mm).

C. Epoxy Resin Sinks:
1. Mold sinks from thermosetting epoxy resin.
2. Mold interior corners to radius. Slope sink base to drain outlet.
3. Provide 1-1/2 inch (38 mm) outlet with open ended standpipe; standpipe overflow 2 inches (50 mm) shorter than depth of sink.
4. Unless otherwise indicated, fabricate sinks of drop-in design supported by upper flange from worksurface.
5. Color: To match adjacent worksurface.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until cabinets have been installed.

B. Confirm that surfaces to receive tops are plumb and level, with maximum deflection of 1/4 inch (6 mm) in 20 feet (6 m).

3.2 PREPARATION

A. Clean surfaces just prior to installation.

B. Prepare surfaces using methods recommended by manufacturer.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved Shop Drawings.

B. Install tops plumb and level.

C. Scribe to adjacent surfaces in accordance with manufacturer's recommendations.

D. Fasten tops to supporting construction with adhesives appropriate for use with adjoining construction and as recommended by manufacturer.

E. Form field joints using manufacturer's recommended adhesive. Form joints to be inconspicuous and nonporous.

3.4 PROTECTION

A. Protect installed products until completion of Project.

B. Touch up, repair, or replace damaged products.

END OF SECTION

DIVISION 13
SPECIAL CONSTRUCTION

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SECTION 13 47 13
CATHODIC PROTECTION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section covers the work necessary to furnish and install a galvanic cathodic protection system, test stations, electrical isolation, and electrical continuity on all buried steel piping, complete.

1.2 DEFINITIONS

A. Ferrous Metal Pipe: Pipe made of steel or iron, or pipe containing steel or iron as a principal structural material, except reinforced concrete pipe.

B. Foreign-Owned: Buried pipe or cable not specifically owned or operated by the Owner.

C. Lead, Lead Wire, Joint Bonds, Pipe Connecting Wires, Cable: Insulated copper conductor; the same as wire.

D. Electrically Continuous Pipeline: A pipeline which has a linear electrical resistance equal to or less than the sum of the resistance of the pipe plus the maximum allowable bond resistance for each joint as specified in this section.

E. Electrical Isolation: The condition of being electrically isolated from other metallic structures (including, but not limited to, piping, reinforcement, casings) and the environment as defined in NACE Recommended Practice RP0169-83.

1.3 SUBMITTALS

A. Shop Drawings: Catalog cuts and other information for products proposed for use.

B. Quality Assurance Submittals:
   1. Manufacturers' Certificates of Compliance.
   2. Field Test Reports.

PART 2 - PRODUCTS

2.1 GENERAL

A. Like items of materials provided hereunder shall be the product of one manufacturer to achieve standardization for appearance, maintenance, and replacement.

B. The use of a manufacturer's name and model or catalog number is for establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with the General Conditions.

C. Materials and workmanship as specified in this section shall be installed concurrently with pipe installation. Coordinate all work specified herein with related sections.

2.2 SUPPLIERS

A. Alternate suppliers will be considered, subject to approval of the Engineer. Address given is that of the general office; contact these offices for information regarding the location of their representative nearest the project site.
1. Corrpro, Medina, OH
2. Farwest Corrosion Control, Gardena, CA
3. Mesa Products, Tulsa, OK

2.3 GALVANIC RIBBON ANODE

A. Magnesium Ribbon Anodes
1. Composition:

a.	Aluminum:	0.01 percent maximum.
b.	Manganese:	0.5 to 1.3 percent.
c.	Zinc:	0.0 percent
d.	Silicon:	0.0 percent
e.	Copper:	0.02 percent maximum.
f.	Nickel:	0.001 percent maximum.
g.	Iron:	0.03 percent maximum.
h.	Total Others:	0.05 percent each or 0.3 percent maximum.
i.	Magnesium:	Remainder.

2. Magnesium ribbon anodes for buried ferrous metal pipe and conduit shall be ribbon anodes weighing 0.24 pounds per lineal foot and shall be 3/4-inch wide by 3/8-inch thick.
3. Continuously extrude alloy over a No. 11 gauge, minimum, iron wire core centrally located within the ribbon.

2.4 ANODE BACKFILL

A. Backfill galvanic ribbon anodes with a mixture of the following composition:

1.	Ground Hydrated Gypsum	50 percent
2.	Powdered Wyoming Bentonite	50 percent

B. Backfill shall have a grain size so that 100 percent is capable of passing through a 20-mesh screen and 50 percent will be retained by a 100-mesh screen. The backfill mixture shall be thoroughly mixed.

2.5 GALVANIC ANODES

A. High-Potential Magnesium Alloy (Prepackaged-Backfill Supplied):
1. Composition:
   a. Aluminum: 0.01 percent maximum.
   b. Manganese: 0.5 to 1.3 percent.
   c. Zinc: 0.
   d. Silicon: 0.
   e. Copper: 0.02 percent maximum.

f. Nickel: 0.001 percent maximum.
g. Iron: 0.03 percent maximum.
h. Total Others: 0.05 percent each or 0.3 percent maximum, total.
i. Magnesium: Remainder.

2. Dimensions:
   a. Bare Weight: 20 pounds.
3. Manufacturers and Products:
   a. Dow; Galvomag.
   b. Amax; Maxmag.

B. Backfill:
1. Composition:
   a. Ground Hydrated Gypsum: 75 percent.
   b. Powdered Wyoming Bentonite: 20 percent.
   c. Anhydrous Sodium Sulfate: 5 percent.
2. Grain Size: 100 percent passing through a 20-mesh screen and 50 percent retained by a 100-mesh screen.
3. Mixture: Thoroughly mixed and firmly packaged around the galvanic anode within the cloth bag or cardboard tube by means of adequate vibration.
4. The quantity of backfill shall be sufficient to cover surfaces of the anode to a depth of 1 inch.

2.6 CATHODIC PROTECTION TEST STATIONS

A. Post Mounted (Standard):
1. Test Box: Cast aluminum with thread lid and suitable for threaded mounting to a 1-inch or larger rigid galvanized steel conduit.
2. Terminal Block: Plastic or glass-reinforced laminate, 1/4-inch thick with seven terminals. Terminal heads shall have special heads to keep them from turning or shall be easily accessible from both sides of the terminal block without requiring its removal. Terminal studs, washers, and nuts shall be stainless steel.
3. Mounting Post: 4-inch by 6-inch nominal AWPB LP-22 preservative-treated wood post, 5-feet long.
4. Mounting Hardware: Galvanized steel rigid conduit, straps, and mounting hardware.
5. Manufacturer and Product: Testox; 800 series test stations for all test stations, except Type AR-1

B. Post Mounted (Type AR-1):
1. Test Box: Cast aluminum with lid and suitable for threaded mounting to a 1 ½-inch or larger rigid galvanized steel conduit.
2. Terminal Block: Plastic or glass-reinforced laminate, ¼-inch thick with seven terminals. Terminal heads shall have special heads to keep them from turning or shall be easily accessible from both sides of the terminal block without requiring its removal. Terminal studs, washers, and nuts shall be stainless steel.
3. Mounting Post: 4-inch by 6-inch nominal AWPB LP-22 preservative-treated wood post, 5-feet long.
4. Mounting Hardware: Galvanized steel rigid conduit, straps, and mounting hardware.
5. Manufacturer and Product: Testox 2000 Series test station for Type AR-1.

2.7 JOINT BONDS

A. Coated Steel Pipe:
   1. Solid copper strap, 1-1/4-inch wide by 1/16-inch thick, equivalent to 1/0 AWG wire, with two punched holes for thermite welding to the pipe. Strap bond shall be 12-inches long.
   2. Welding of bond to pipe shall be with the thermite weld mold recommended by the bond manufacturer.
   3. Strap bond shall be as manufactured by Erico Products, Continental Industries, or approved equal.

B. Flexible Coupling, Flanged Coupling Adapter, and Other Non-standard Joints:
   1. Solid copper strap, 1-1/4-inch wide by 1/16-inch thick, equivalent to 1/0 AWG wire, with five punched holes for thermite welding to the coupling and pipe. Strap bond shall be fabricated for the length of the coupling with sufficient additional length for 1 inch of joint movement.
   2. Weld bonds to pipe with the thermite weld mold recommended by the bond manufacturer.
   3. Strap bond shall be as manufactured by Erico Products, Continental Industries, or approved equal.

2.8 WIRE

A. General: Conform to applicable requirements of NEMA WC 3-80, WC 5-73, and WC 7-88.

B. Test Station: Single-conductor, No. 12 AWG and No. 8 AWG stranded copper with 600-volt TW, THWN, or THHN insulation.

C. Galvanic Ribbon Anodes and Anode Header Wire: Single-conductor, No. 8 AWG, stranded copper with 600-volt HMWPE insulation.

D. Color: Insulation color shall be as follows:
   1. Galvanic Anodes: Black
   2. Pipeline test wires: White
   3. Foreign Pipelines: Blue (water) or Red (gas).
   4. Casings: Orange
   5. Insulating Joints White and Green, as shown on drawings.

2.9 THERMITE WELD MATERIALS

A. General:
   1. Thermite weld materials consist of wire sleeves, welders, and weld cartridges according to the weld manufacturer's recommendations for each wire size and pipe or fitting size and material.
   2. Welding materials and equipment shall be the product of a single manufacturer. Interchanging materials of different manufacturers is not acceptable.

B. Molds: Graphite. Ceramic "One-Shot" molds not acceptable.

C. Adapter Sleeves:

1. For No. 12 AWG and No. 2 AWG wires.
2. Prefabricated factory sleeve joint bonds or bond wires with formed sleeves made in the field are acceptable. Attach field-formed joint bonds sleeves with the appropriate size and type of hammer die furnished by the thermite weld manufacturer.
3. Extend wire conductor 1/8 inch beyond the end of the adapter sleeve.

D. Cartridges:
1. Steel: 32 grams, maximum.
2. Cast and Ductile Iron: 45 grams, maximum, XF-19 Alloy

E. Welders and Cartridges: For attaching copper wire to pipe material:

Pipe Material	**Weld Type**	**Cartridge Size, Max.**
No. 4 AWG Wire & Smaller		
Steel	HA, VS, HC	25 gm
Ductile and Cast Iron	HB, VH, HE	32 gm

F. Welding Materials Manufacturers:
1. Erico Products Inc. (Cadweld), Cleveland, OH.
2. Continental Industries, Inc. (Thermo-Weld), Tulsa, OK.

2.10 COATING REPAIR MATERIAL FOR PIPE AND FITTINGS

A. General:
1. Complete coating repairs in accordance with recommendations of the pipe or fitting manufacturer.
2. Coat steel pipe with epoxy coating repair as specified.
3. Coat thermite weld connections to ductile iron pipe with fast cure epoxy or thermite weld cap.

B. Thermite Weld Caps: Prefabricated weld cap with coating and primer, if required, such as Handy Cap IP as manufactured by Royston Laboratories, Inc.

C. Epoxy Coating:
1. 100 percent solids, fast curing epoxy suitable for submerged or buried conditions.
2. Acceptable products and manufacturers or equal:
   a. Aquata-poxy, American Chemical Corp., East Lake, OH.
   b. Protal 7125, Denso North American, Houston, TX.
   c. TC 7010, Tapecoat, Evanston, IL.

2.11 ANCILLARY MATERIALS

A. Geotextile Fabric: Commercial grade, filter fabric, suitable for fines.

B. Wire Connectors: One-piece, tin-plated crimp-on ring tongue connector as manufactured by Burndy Co. or Thomas and Betts.

C. Shunts: Shunts shall be 0.01-ohm Holloway Type RS.

D. Compression Connectors:
   1. For in-line, tap, and multi-splice, furnish "C" taps made of conductive wrought copper, sized to fit the wires being spliced.
   2. Provide crimp tool and dies as recommended by the manufacturer for the wire and connector size.
   3. Manufacturer and Product: Burndy; Type YC, or equal.

E. Electrical Tape:
   1. Linerless rubber high-voltage splicing tape and vinyl electrical tape suitable for moist and wet environments.
   2. Use Scotch 130 C and Scotch 88 as manufactured by 3M Products.

2.12 CONCRETE

A. Form Work: Plywood or lumber

B. Mix: ASTM C94-90, Option A.
   1. Cement: ASTM C150-89, Type V.
   2. Coarse Aggregate Size: 3/4 inch(es).
   3. Design for Minimum Compressive Strength at 28 Days: 3,000 psi.

2.13 INSULATING JOINTS

A. General: Insulating joints shall be dielectric unions, flanges, or couplings. The complete assembly shall have an ANSI rating equal to or higher than that of the joint and pipeline. All materials shall be resistant for the intended exposure, operating temperatures, and products in the pipeline.

B. Insulating Flange Joints:
   1. Complete assembly shall have an ANSI rating of 150 pounds, minimum, or equal to or higher than that of the joint and pipeline.
   2. Gasket materials shall be resistant to intended chemical exposure, operating temperatures, and pressures in the pipeline.
   3. Gaskets: Full-face Type E with O-ring seal.
   4. Insulating Sleeves: Full-length fiberglass reinforced epoxy (NEMA G-10 grade).
   5. Insulating Washers: Fiberglass reinforced epoxy (NEMA G-10 grade).]
   6. Steel Washers: Plated, hot-rolled steel, 1/8-inch thick.
   7. Manufacturers:
      a. Pacific Seal, Inc., Burbank, CA.
      b. Central Plastics Co., Shawnee, OK.

PART 3 - WORKMANSHIP

3.1 GENERAL

A. Construct a galvanic anode cathodic protection system with ribbon anodes and prepackaged galvanic anodes including test stations and insulating joints. Installation of anodes to be performed in conjunction with pipeline trenching and installation as specified in other sections.

B. All materials and equipment associated with joint bonding, test stations, and insulating joints as shown and specified herein shall be furnished and installed by the Contractor. Any changes in design or method of installation of an item as specified shall be reviewed by the Engineer.

C. The Contractor shall coordinate the installation of the specified items with the General Contractor or other subcontractors on the project such that installation of the items herein specified can be completed concurrently with pipeline installation. Items not installed before backfilling of the pipe shall be installed at the Contractor's sole expense.

D. Whenever the requirements of the Specifications or Drawings exceed those of the codes or manufacturer's instructions, the requirements of the Specifications or Drawings shall prevail. Where a larger size or better grade of material or a higher standard of workmanship is required, the most stringent requirement shall apply.

3.2 STORAGE AND HANDLING

A. Store all prepackaged anodes, anode backfill, and test stations off the ground and keep them dry at all times.

B. Protect materials against weather, condensation, and mechanical damage. Immediately remove from site all damaged anodes.

C. Anode backfill material that has become wet will not be acceptable.

3.3 GALVANIC RIBBON ANODE INSTALLATION:

A. Cathodically protect buried ferrous metal pipe with galvanic ribbon anodes. Install ribbon anodes concurrently with pipeline at the position shown on the Drawings or at depth of 4 feet minimum.

B. Ribbon anodes shall be installed along the buried ferrous metal pipe. Minimum anode length shall be as shown on Drawings unless approved by the Engineer.

C. Maintain 12-inches separation between the pipe and ribbon anode. At foreign pipeline crossings, maintain a minimum of 10 inches clearance between the pipe and ribbon anode.

D. Place anode backfill material over full length of ribbon anode. Maintain 2-inch minimum backfill cover over all sides of anode. Cover anode backfill with geotextile fabric and wet fabric and backfill prior to placement of pipe zone backfill or trench backfill.

E. Carefully place pipe zone backfill or trench material over wetted anode backfill in accordance with pipe trench backfilling specifications.

F. Bury anode wires to test station a minimum of 36-inches below finished grade.

G. Connect ribbon anode to the pipe within a Type AR test station as shown on the Plans. Direct electrical connection of the anode to the pipe will not be acceptable.

H. Attachment of the lead wires to the ribbon anodes shall be made by removing the galvanic anode alloy from the iron core and installing a compression connector around the wire and anode core as shown on the Drawings. Use extreme caution when melting magnesium as alloy is combustible.

3.4 GALVANIC ANODE INSTALLATION

A. General: Install galvanic anodes and groundbeds as shown on the Drawings. Provide a minimum anode spacing of 2 feet from other unprotected pipelines. Galvanic anodes packaged in cardboard type chip-tube shall be thoroughly perforated just prior to installation.

3.5 TEST STATION INSTALLATION

A. Location, type, and style of test stations shall be as shown on the Schedules on the Drawings. Final field location shall be determined based on actual site conditions and as approved by the Engineer.

B. Test stations shall be generally located as follows:
   1. Install Type T test stations or other type test stations as appropriate at 1,500-foot intervals or less.
   2. Install a Type F test station where any ferrous metal pipe crosses a metallic foreign-owned pipeline under cathodic protection or indicated on the Drawings.
   3. Install a Type I test station at all buried insulated joints.
   4. Install a Type A test station at buried laterals, dished heads, and connection piping as shown on the Drawings.
   5. Install a Type AR-1 test station at galvanic ribbon anode locations as shown on the Drawings.

C. Post mounted test stations shall be installed as follows:
   1. Place post mounted test stations centered over the pipeline, except in cultivated fields or roadways, where test station shall be located at aboveground pipeline appurtenances, fence lines, or other protective structure or location.
   2. When protective structures or fence lines do not exist, offset test station to:
      a. Parallel fence line,
      b. Behind curb of street, or
      c. As approved by the Engineer

D. Attach all test wires to the pipe by the thermite weld method unless approved otherwise.

E. Wires to foreign owned pipelines will be attached by the Contractor unless foreign pipeline owner requests work to be performed by their personnel. Coordinate this Work with the foreign pipeline owner before excavating pipe.

F. The wires from the test stations shall be buried a minimum of 36 inches below finished grade. Provide 12-inch loop in wires at pipe and beneath test station to prevent them from being stressed or broken during backfilling operations.

G. Test wires with less than 36 inches of ground cover shall be installed in rigid PVC coated steel conduit, except when located under concrete floor slabs.

H. Make wire connections to test station terminals with crimp-on ring tongue terminals, except where solid wire is specified.

3.6 PIPE JOINT BONDING

A. To form an electrically continuous pipeline and associated appurtenances, the joints of all buried steel and iron pipe, vault and manhole piping, fittings, and restrained joints shall be provided with joint bonds as specified herein, except joints specified to be threaded, welded, or insulated.

B. Install the quantity of joint bond wire assemblies as shown in the following table.

	Number of Joint Bonds	
Pipe Size	**Steel Pipe**	**Ductile Iron**
Less than 14-inch diameter	2 per joint	1 per joint
16” to 36” diameter	2 per joint	2 per joint
Greater than 36” diameter	3 per joint	3 per joint

C. Electrical connection of all wires to pipe and fittings shall be by the thermite weld process.

D. Each bonded joint shall be tested as specified under ELECTRICAL CONTINUITY TESTING, this section.

3.7 WIRE CONNECTIONS

A. Thermite Weld:
1. Use thermite weld method for electrical connection of copper wire to steel, ductile, and cast iron surfaces. Observe proper safety precautions, welding procedures, thermite weld material selection, and surface preparation recommended by the welder manufacturer. Assure that the pipe or fitting wall thickness is of sufficient thickness that the thermite weld process will not damage the integrity of the pipe or fitting wall or protective lining.
2. After the weld connection has cooled, remove slag, visually inspect, and physically test wire connection by tapping with a hammer; remove and replace any defective connections.
3. On pipe and fittings with dielectric linings, make the weld connection on the shop tab provided or on a thick metal section to minimize damage to the lining and coating. After the weld is made, coat the weld with coating repair material.
4. Coat each completed wire connection as specified, this section. If the lining is damaged by welding, repair in accordance with the lining applicator's recommendations.

3.8 WIRE INSULATION REPAIR

A. Splicing of wire will not be permitted except where specifically shown on the drawings and approved by the Engineer.

B. Splices or damage to the wire insulation shall be required by spirally wrapping with two coats of high-voltage rubber splicing tap and two layers of vinyl electrical tape.

C. Make wire splices with suitable sized compression connectors or mechanically secure and solder with rosin cored 50/50 solder.

3.9 INSULATED JOINTS

A. Install insulated joints to electrically isolate the pipeline as shown on the Drawings.

B. Align and install insulating joints according to the manufacturer's recommendations to avoid damaging insulating materials.

C. After assembly of insulated flanges, prepare cement-mortar surface in accordance with paint manufacturer's instructions and apply a 20-mil minimum thickness of EPA potable water approved, 100 percent solids water or air curing epoxy coating to the interior of the pipeline. Apply coating for a minimum of two pipe diameter lengths from the insulating flange in both directions. Apply and cure coating in accordance with the manufacturer's recommendations. Do not apply coating where it will interfere with operation of pipeline valves or other pipeline assemblies.

D. Install a Type I test station at each insulated joint.

E. The Contractor shall test each insulated joint for electrical insulation as specified this section. Defective insulating joints shall be repaired by the Contractor at his sole expense. All damaged or defective insulation parts shall be replaced.

3.10 TESTS AND INSPECTION

A. Electrical Continuity Testing:
   1. General
      a. Furnish all necessary equipment and materials and make all electrical connections to the pipe as required to test continuity of bonded joints.
      b. Conduct a continuity test on all buried joints that are required to be bonded. Test the electrical continuity of joint bonds after the bonds are installed but before backfilling of the pipe.
   2. Digital Low Resistance Ohmmeter Continuity Test Method:
      a. Required Equipment And Materials:
         1) One AVO Model 247001 digital low resistance ohmmeter.
         2) One set of duplex helical current and potential handspikes, AVO Model No. 241001, cable length as required.
      b. Test Procedure:
         1) Measure the resistance of joint bonds with the low resistance ohmmeter in accordance with the manufacturer's written instructions.
         2) Use the helical handspikes to contact the pipe on each side of the joint, without touching the thermite weld or the bond. The contact area shall be cleaned to bright metal by filing or grinding and without any surface rusting or oxidation.
         3) Record the measured joint bond resistance on the test form described herein.

4) Repair any damaged pipe coating in accordance with WIRE CONNECTIONS, this section.

3. Joint Bond Acceptance:
   a. Joint bond resistance shall be less than or equal to the maximum allowable bond resistance values shown in Table 1.

Table 1

Joint Type	Max. Allowable Resistance (Ohms) One bond/Joint	Two Bonds/Joint	Three Bonds/Joint
No. 2 AWG wire Bonds	0.000325	0.000162	0.000081
Copper Straps	0.000165	0.000083	0.000050
Flexible Coupling	0.000425	0.000212	0.000115
MLC Steel Pipe Clips	Not Allowed	Not Allowed	0.000055

   b. The Contractor shall replace any joint bond that exceeds the allowable resistance. Replacement joint bonds shall be retested for compliance with the specified bond resistance.
   c. Any defective joint bond discovered during energizing and testing shall be located, excavated, repaired, and backfilled by the Contractor.
4. Test Records: Records shall be made of each bonded pipeline during the test and submitted to the Engineer. These records shall include:
   a. Description and location of the pipeline tested.
   b. Starting location and direction of test or pipe joint stationing.
   c. Date of test.
   d. Joint type.
   e. Measured joint bond resistance

B. Final Electrical Continuity Test:
1. After the pipeline construction is completed and test stations have been installed, the Engineer shall test the completed pipeline for electrical continuity using the four-wire lineal pipe resistance test method.
2. Test will be conducted with a minimum test current of 10 amperes using a portable rectifier or dc welder.
3. An electrically continuous pipeline will be defined as a pipe or section of pipe that has a linear electrical resistance equal to or less than the sum of the lineal resistance of the pipe plus the maximum allowable joint bond resistance for each joint within the test section as specified this section.
4. Each discontinuous section of pipe shall be retested after all continuity repairs are completed to demonstrate that the pipeline is electrically continuous.

C. Electrical Discontinuity Location:
1. If electrically discontinuous sections of pipe are detected during final continuity testing, the Contractor to locate and repair electrically discontinuous joint bonds at his sole expense.
2. Location of discontinuous joints bonds may be performed using a test method determined by the Contractor. Regardless of test method used to locate discontinuous joints, final acceptance of discontinuous sections shall be determined by the lineal pipe resistance method.

3. After all discontinuous joints are repaired, the repaired section shall have a resistance less than or equal to the calculated allowable lineal pipe resistance as determined by the initial final continuity testing.
4. Existing joint bonds damaged during excavation of the pipe for repairs or temporary wire connection shall be repaired by the Contractor.
5. Existing test stations shall be protected from damage. When damage occurs Contractor shall complete repairs while the excavation is open. Undisclosed test station damage that requires repairs to be made after backfilling the excavation will be repaired at the Contractor sole expense.

D. Insulated Joint Testing:
1. Test each insulating joint after assembly with a GAS Electronics Model 601 insulator tester or equivalent instrument in accordance with the manufacturer's written instructions. Conduct test before burial and coating of buried insulating flanges.
2. Contractor to replace damaged or defective insulation parts identified during testing.
3. Electrical Isolation is defined as a condition of being electrically isolated from other metallic structures (including, but not limited to, other piping, concrete reinforcement, casings, and other structures not intended to be cathodically protected) and the environment as defined in NACE Recommended Practice RP0169-83.
4. Engineer shall conduct additional insulating joint tests as required to insure that insulating flanges are not electrically shorted by other equipment or incidental contact with concrete reinforcement or other equipment during energizing and testing.

E. Cathodic Protection System Energizing and Testing:
1. After the installation of the cathodic protection system is completed, the Engineer shall connect the anodes to the pipe in test stations and make sufficient tests throughout the network of protected pipe to ensure proper installation of the cathodic protection system.
2. Upon completion of such tests, the Engineer who conducted the tests shall tabulate the data recorded.

END OF SECTION

SECTION 13 66 50
BLADDER SURGE TANKS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes: HYDROPNEUMATIC BLADDER STYLE SURGE TANKS.

B. Related Sections:
1. Section 01 33 20 – Contractor Submittals
2. Section 09 90 01 – Protective Coatings
3. Section 40 05 10 – Mill Piping

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. A 36 - Specification for Structural Steel.

B. American Society of Mechanical Engineers (ASME):
1. ASME Code – Latest revision of Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Pressure Vessels, Division 1.

C. Code of Federal Regulations (CFR):
1. 49 CFR 173.315 - Code of Federal Regulations, Part 173, Section 315 - Compressed Gases in Cargo Tanks and Portable Tanks.
2. 49 CFR 178 - Code of Federal Regulations, Part 178, Subpart J - Specifications for Containers for Motor Vehicle Transportation.

D. All local Plumbing Codes shall be met.

E. The system and anchorage of the surge tank shall conform to the International Building Code (IBC).

F. The National Electric Code (NEC) shall be used for all wiring.

1.3 SYSTEM DESCRIPTION

A. The surge control system shall be designed, fabricated, installed and warranted by a single supplier to meet the functional and performance requirements specified herein.

B. The work included in this section consists of the furnishing of all labor, materials, equipment, testing and appurtenances for surge protection at each location specified to prevent column separation and/or to limit surge under the conditions specified.

C. The bladder type surge tank shall consist of a cylindrical pressure tank for surge control, including: bladder, shell assembly, gas plate assembly, rupture disc, pressure gauges, accessories, valves, connection piping, and other miscellaneous appurtenances

1.4 SUBMITTALS

A. General: Supply the information required below in accordance with Section 01 33 20 – Contractor Submittals.

B. Product Data: List of materials and coatings used. All materials in contact with water shall be NSF certified.

C. Shop Drawings and Calculations:
1. Detail drawings or manufacturer's literature to indicate compliance with the specified requirements.
2. Dimensional drawings indicating vessel dimensions, wall thickness, mounting, and anchorage requirements.
3. Hydraulic calculations as required herein.
4. Copy of structural, seismic, and wind loading calculations for the support system signed by a Structural Engineer registered in the state where the Project is located.
5. Layout drawings showing dimensions of equipment and accessories.
6. Manufacturer's catalog data on all appurtenances.
7. Submit electrical schematic and wiring diagrams showing wiring, monitoring, and terminals. Label each terminal, showing which control or electrical power wire connects to which terminal.

D. Owner's Manual:
1. Certification and ASME Code data reports in accordance with the ASME Code and as applicable 49 CFR 178.337 or other similar codes. The certification shall include certification of joint radiography, and hydrostatic testing.
2. Fabrication drawings.
3. Operation and maintenance data and instructions.
4. Certificate of installation, signed by authorized supplier/manufacturer representative following field inspection, functional testing and performance testing of systems.

E. Manufacturer's Warranty
1. Manufacturer warranty or warranties for the surge tank and all appurtenances. Said warranties shall be issued to Owner and shall be valid for a period of 2 years following installation.

PART 2 – PRODUCTS

2.1 GENERAL

Provide two Hydropneumatic Bladder Style Surge Tanks as outlined in the following sections.

A. Hydraulic Design:
1. Hydraulic surge tank design as shown in the contract documents is as follows:

Tank # TNK-1564	**Value**
Service	Finished Water (Culinary)
Volume	1,100 gallons

Dimensions	As shown in drawings
Initial Pre-charge Pressure	95 psi
Hydraulic Resistance Out of Tank (Including connection piping)	0.04 ft/cfs^2
Hydraulic Resistance In to Tank (Including connection piping)	10.4 ft/cfs^2

Tank # TNK-1674	**Value**
Service	Snowmaking Water
Volume	1,600 gallons
Dimensions	As shown in drawings
Initial Pre-charge Pressure	165 psi
Hydraulic Resistance Out of Tank (Including connection piping)	0.02 ft/cfs^2
Hydraulic Resistance In to Tank (Including connection piping)	10.4 ft/cfs^2

2. System Parameters:

Tank # TNK-1564: The system for which the surge control is to be provided consists of a finished water pump station rated at 350 psig. Additional information related to the pump station include:

Tank # TNK-1564	**Value**
Service	Finished Water (NSF)
Maximum Flow rate through pump station	5,556 gpm (future max)
System static pressure	280 psig
Maximum steady operating pressure	315 psig
Maximum pressure due to surge	310 psig (at surge tank)
Minimum pressure due to surge	85 psig (at surge tank)
Water temperature range	0-30°C

Tank # TNK-1674: The system for which the surge control is to be provided consists of a snowmaking water pump station rated at 350 psig. Additional information related to the pump station include:

Tank # TNK-1674	**Value**
Service	Snowmaking Water
Maximum Flow rate through pump station	10,000 gpm
System static pressure	265 psig
Maximum steady operating pressure	290 psig
Maximum pressure due to surge	300 psig (at surge tank)
Minimum pressure due to surge	140 psig (at surge tank)
Water temperature range	0-30°C

The two pressure vessels are to be connected to the pipelines as shown on the drawings. The hydraulic and pressure surge analysis is available on request from the Engineer.

B. Pressure Vessel:

1. Materials for the tank, design, and shop fabrication and inspection shall comply with Section VIII of the ASME Boiler and Pressure Vessel Code for Unfired Pressure Vessels, with only the plate steels in Table UCS-23 of said code being used. The design pressure rating of the vessel shall be at least the lesser of 50 percent or 50 pounds per square inch gauge above the maximum allowable pressure due to surge. A 1/16 inch corrosion allowance shall be included in all shell, heads, and attachment thicknesses.
2. Provide ASME Code stamp and pressure rating on pressure vessel.
3. Welding: Weld reinforcement shall be in accordance with ASME Code. Excessive reinforcement shall be ground down to within the ASME Code requirements, and as required to install the lining systems. All internal corners and edges shall be ground to a 1/8 inch radius, or a greater radius if required by the lining system.
4. Protective Lining: Interior surfaces of the tank shall be factory-coated with a polyamide epoxy coating, NSF certified, percent of volume solids 75% minimum, (Devoe Bar-Rust 233H or Equal). Apply minimum of 3 coats, with a minimum dry film thickness of 18 mils (total thickness all coats). See Section 09 90 01.
5. External Coating: Finished coating to be factory-coated with a polyamide epoxy coating, NSF certified, percent of volume solids 75% minimum, (Devoe Bar-Rust 233H or Equal). Apply minimum of 3 coats, with a minimum dry film thickness of 18 mils (total thickness all coats). The finish coat is to be shop applied with touch up painting as necessary in the field. See Section 09 90 01.
6. Tank shall be equipped with an anti-extrusion grid which prevents the bladder from being sucked out of the tank in case of loss of line pressure. Head loss associated with the anti-extrusion grid shall be included in the calculation of total connection resistance.
7. All submerged, wetted, or internal items shall be Type 304 or 316 stainless steel.
8. Provide minimum 20" round opening for access manhole, flanged outlet for pipe connection to manifold header, threaded couplings for connecting gages, valves, air piping and drain. Couplings shall be 3,000-pound, WOG forged stainless steel, per ASTM A 182 F 304. Threads shall comply with ANSI B2.1. Joint lubricant shall be Teflon joint compound or Teflon tape.
9. Structural Design: Design tank for seismic, wind load, and other design criteria consistent with other component of the project and as required by local regulations, which may require an external structure to support the tank.
10. Vertical tanks shall be supported laterally for seismic restraint, which may include separate structural supports. These supports along with the tank legs, saddle supports, and anchor nuts/bolts shall be sized appropriately to resist movement in a seismic event per the current codes. Seismic design calculations shall be stamped by a licensed structural engineer in the state of Utah and submitted for review.
11. Environmental Service Conditions: As shown on the Drawings, General and/or Structural Notes.
12. Install air lines to drain condensate traps/drains as required and/or shown on the Drawings.
13. Tank to be equipped with a Parker B17 Quick Disconnect (or equal) air valve fitting with a ½" ball valve charging connection to facilitate the on-site charging of the tank. Tank to be precharged with nitrogen gas per the precharge pressure specified.
14. Tank to include a replaceable heavy-duty butyl rubber bladder (IIR) (or equal) designed for both the precharge and system pressures specified. In no case shall the bladder have a thickness less than 0.100".

15. The tank shall be fitted with a 304 or 316 stainless steel perforated plate to prevent the bladder from escaping through the fluid port. The presence of this plate shall be included in the resistance calculations for surge tank system.
16. The bladder surge tank shall be equipped with a non-intrusive volume indicator device to monitor gas volume levels without disrupting tank operations.

C. Connection piping:
1. All piping, fittings, flanges, valves, and other connection piping appurtenances shall be rated for a pressure of no less than the design pressure for the tank.
2. All connection piping to the tank shall be designed such that total hydraulic resistance into and out of the tank is within the range specified. Supplier shall provide resistance calculations for the piping and tank system. Any orifice plate or other head loss device required to meet resistance specifications shall be designed and furnished as part of the overall connection piping and tank system. Where resistance requirements cannot be obtained using a single connection pipe, tank supplier shall design and furnish a manifold system (including check valve, bypass piping, etc.) to obtain the required resistance.
a. Manifold System. Contract drawings assume a drilled check valve (preferred system) which is desired to save space compared to bypass piping. Manufacturer shall show that a drilled check valve system will meet specified resistance requirements using a Mueller 72 or equal. If manufacturer cannot meet resistance with drilled check valve, the Manufacturer is to provide a 2-inch diameter bypass piping system with mechanical coupling and must show that it can meet specified resistance requirements.
3. Coating: Coat connection piping and appurtenances as specified in Section 09 90 01.

D. Safety-Relief Valve: Safety-relief valve shall comply with the ASME Boiler and Pressure Vessel Code. Valve shall be bronze, and shall have a pressure rating of appropriate for the pressure rating of the tank. Valve shall have a bottom NPT inlet, and shall have incorporated a calibrated spring set to allow the valve to open at the tank design pressure. Valve shall be a Kunkle Model 919 or approved equal.

2.2 MONITORING DEVICES

A. Differential Pressure Transmitters (via two pressure transmitters), provided by tank supplier. See Drawings and Division 40 for equipment specification. Contractor to ensure that transmitter model is consistent throughout the project.

B. Bladder Monitoring Device: magnetic level gage (MLG) provided by tank supplier.

2.3 COMPONENTS

A. Lifting Lugs: Provide lifting lugs.

B. Anchor Bolts: Anchor bolts shall have a nominal diameter of at least 3/4 inch, unless otherwise indicated on the Drawings, and shall be anchored to concrete foundations using methods designed to transfer the full ultimate strength of the anchor bolt to the concrete

foundation. Attach anchor bolts to the tank by use of anchor bolt chairs or rings, as required. Chairs or rings shall be designed to transfer 125 percent of the ultimate strength of the bolt, or 150 percent of the calculated load, whichever is less, to the tank shell.

C. Nameplates and Code Stamps: Design, fabricate, and test tanks in accordance with the ASME Code. Each tank shall bear a stainless steel ASME nameplate. Each nameplate shall bear the applicable code symbol. Manufacturer shall be authorized by ASME to apply the applicable code symbols.

D. Fittings and Attachments: Fittings larger than 1 inch shall be flanged. Fittings 1 inch and smaller shall be National Pipe Thread. Reinforce openings in accordance with the ASME Code. Access openings shall be flanged, and, unless otherwise indicated on the Drawings, have a nominal diameter of at least 20 inches. The cover plate and flange of access openings shall each have a net thickness, after machining, of at least 1/2 inch or as required to meet the vessel design pressure.

E. Attachments: Weld shell attachments for pipe supports, tank gages, instruments, and other items as indicated on the Drawings before application of the tank lining.

2.3 SOURCE QUALITY CONTROL

A. Tests: After fabrication, but prior to application of linings each tank shall be tested in accordance with the ASME Code.

2.4 MANUFACTURERS

A. Experience: The manufacturer shall be experienced for at least 5 years in the design and operation of surge control systems and shall provide a list of similar installations for review by the Engineer.

B. Surge Tanks: One of the following or equal:

1. Pulsco
2. Charlatte Tanks
3. Young Engineering

PART 3 – EXECUTION

3.1 INSTALLATION

A. Special Techniques: Install in accordance with the recommendations of the manufacturer, shop drawings, applicable codes and Contract Documents. Tanks shall be installed level and plumb and shall be secured via their anchor bolt system to transfer all vertical and horizontal loads to their concrete foundations. All appurtenances shall be configured and oriented for easy access as required for tank operation and maintenance.

B. Air Charging: Fully charge with air in accordance with the manufacturer's instructions prior to field testing the system. Final adjustments in pressure shall be made after installation.

C. Contractor is to obtain the required OSHA Pressure Vessel operating permit.

D. Manufacturer's Services: Trained personnel representing the surge tank manufacturer shall check the installation and instruct the Owner's personnel in the operation of the surge control system. A field test of the equipment by the manufacturer's representative shall also be performed in conjunction with this site visit.

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DIVISION 23
HVAC

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SECTION 23 00 00
GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS:

The mechanical work described in this Division comprises a part of the total project. This Contractor shall be familiar with the work of other trades and shall coordinate with them throughout the project. In particular, this Division is subject to the requirements and provisions of the General Conditions, Supplemental General Conditions and Special Conditions, and they comprise a part of the work of this Division.

1.2 SCOPE OF THE WORK:

All work defined in these mechanical specifications and on the mechanical drawings shall be performed by this Contractor at no additional cost to the Owner. Architectural, structural, electrical and special drawings and specifications are a part of this work as they define interrelated elements of various systems and in instances may govern locations, arrangements, utility services, size, etc.

For purposes of clarity, the mechanical specification division is subdivided into a number of sections. This subdivision is not intended to define individual trades or the limits of work which may be performed by any one trade. Thus, each trade shall be familiar with all sections of the specification so that the final installation will be a complete and consistent project.

Mechanical specifications include:

Section 23 00 00 - General Mechanical Requirements
Section 23 00 50 - Plumbing and Piping
Section 23 02 50 - Insulation
Section 23 04 10 - Water Distribution Piping and Equipment
Section 23 04 20 - Drainage and Vent Systems
Section 23 04 35 - Floor and Roof Drains
Section 23 04 85 - Natural Gas Piping
Section 23 08 75 - Direct Fired Heating and Ventilating Unit

1.3 GENERAL REQUIREMENTS:

A. PROJECT LOCATION: The mechanical work described in these mechanical specifications is for a new FRWTP Treatment Plant located in Heber City, UT. Design weather conditions are: 95^{o} db, 62^{o} wb, and winter -15^{o}F. Altitude ratings, unless otherwise noted, are for an elevation of 5,600 feet above sea level and adjustments to manufacturer's performance data shall be made accordingly.

B. CODES AND PERMITS: The mechanical work shall be performed in strict accordance with the applicable provisions of the various codes, ordinances and adoptions pertaining to the project location in effect on the date of invitation for bids.

All materials and labor necessary to comply with rules, regulations and ordinances shall be provided. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern.

The Contractor shall hold and save the Owner free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances. Permits necessary for the prosecution of the work under this contract shall be secured and paid for by the contractors. Final inspection by the Architect will not be made nor Certificate of Substantial Completion issued until certificates of acceptability from the inspection authorities are delivered.

C. DRAWINGS:

1. The mechanical drawings show the general arrangement of all piping, ductwork, equipment, etc., and shall be followed as closely as actual building construction and the work of other trades will permit. The architectural and structural drawings shall be considered as part of the work insofar as these drawings furnish the Contractor with information relating to design and construction of the building. Architectural drawings shall take precedence over mechanical drawings. Because of the small scale of the mechanical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves and accessories to meet the conditions as may be required.

2. The Contractor shall verify the dimensions governing the mechanical work at the building. No extra compensation shall be claimed or allowed because of differences between actual dimensions and those indicated on the drawings. He shall examine adjoining work on which mechanical work is dependent for perfect efficiency, and shall report any work which must be corrected. No waiver of responsibility for defective work shall be claimed or allowed due to failure to report unfavorable conditions affecting the mechanical work.

3. Examination of Site: Examination of the site shall be made by the Contractor, who shall compare it with the drawings and specifications and satisfy himself as to the conditions under which the work is to be performed. He shall, at such time, ascertain and check all conditions which may affect his work. No allowance shall subsequently be made in his behalf for any extra expenses to which he may be put due to failure or neglect on his part to make such examination.

1.4 GUARANTEE:

The following guarantee is a part of this specification and shall be binding on the part of the Contractor:

"The Contractor guarantees that this installation is free from mechanical defects. He

agrees to replace or repair, to the satisfaction of the Owner's Representative, any part of this installation which may fail or be determined unacceptable within a period of one (1) year after final acceptance. See also the General Conditions of these specifications."

Mechanical systems and equipment shall not be considered acceptable for substantial completion until they have performed continuously without malfunction for at least ten (10) days.

1.5 OPERATIONS AND MAINTENANCE INSTRUCTIONS:

A. Operation and Maintenance Manual for the mechanical system shall be bound in a hard-backed binder. The front of each binder shall have the following lettering done in silk screen:

OPERATION
AND
MAINTENANCE
MANUAL
FOR
JSSD
TREATMENT PLANT
HEBER CITY, UTAH

1. Provide a master index at the beginning of the manual showing all items included. Use plastic tab indexes for all sections of the book.

2. The first section of the manual shall consist of names, addresses and telephone number of the Architect, Mechanical Engineer, Electrical Engineer, General Contractor, Plumbing Contractor, Sheet Metal Contractor and the Temperature Control Contractor.

3. Provide a section for each different type of item of equipment.

4. Three (3) copies of the Operation and Maintenance Manual shall be provided and submitted to the Owner for approval. One of the three approved copies shall be used during final inspection and left with the building custodian.

B. Descriptive literatures (manufacturer's catalog data) of each manufactured item shall be included. Literature shall show capacities and size of equipment used and shall be marked indicating each specific item with all applicable data underlined.

C. Operating instructions shall include:

1. General description of the mechanical system.

2. Step-by-step procedure to follow in putting each piece of mechanical equipment in operation.

3. Provide schematic control diagrams for each separate fan system, refrigeration system, heating system, control panel, etc. Each diagram shall show locations of start/stop switches, insertion thermostats, thermometers, freezestats, firestats, pressure gauges, automatic valves and refrigeration accessories. Correct operating settings for each control instrument shall be marked on this diagram.

4. Provide diagram for the electrical control system showing the wiring of all related electrical control items, such as freezestats, P.E. switches, firestats, fuses, interlocks, electrical switches and relays.

5. Provide a drawing of each control panel, including temperature control and electrical panels, completely identifying all components on the panels and their function.

6. Maintenance Instructions shall include:
   a. Manufacturer's maintenance instructions for each piece of mechanical equipment installed in the project. Instructions should include installation instructions, parts numbers and lists, operation instructions of equipment, name of vendor, and maintenance and lubrication instructions.

   b. A summary list of each piece of mechanical equipment requiring lubrication, showing the name of the equipment, location, type and frequency of lubrication.

   c. A complete list of all mechanical equipment used indicating name, model, serial number and nameplate data of each item, together with number and name of each system with which the item is associated.

   d. All air balance and test run reports.

1.6 RECORD DRAWINGS:

A. During the course of construction, the Mechanical Contractor shall maintain a set of drawings upon which all deviations from the original layout are recorded. These marked-up prints shall be turned over to the Architect/Engineer at the conclusion of the work. If the Contractor fails to mark up the prints, he shall reimburse the Architect/Engineer for time required to determine the changes made.

1.7 INSTRUCTING OF OWNER'S PERSONNEL:

A. The Mechanical Contractor shall make up and submit a schedule of instruction periods in which the Owner's personnel will receive outlined and prepared instruction in the operation of each piece of equipment and each system, including operation of the overall building as a whole. The Mechanical Contractor, sub-contractors and suppliers shall participate as needed. In particular, the Controls Contractor shall participate to the extent that the Owner and his operators fully understand how the controls operate.

B. Six months after the above instructions are given, the Mechanical Contractor shall provide an additional two hours of instructions.

C. Include travel time and expenses to perform the above training periods.

PART 2 - GENERAL MECHANICAL MATERIALS AND METHODS

2.1 QUALITY OF MATERIALS AND EQUIPMENT:

A. All equipment and materials shall be new, and shall be the standard products of manufacturers regularly engaged in the production of plumbing, heating, ventilating and air conditioning equipment, and shall be the manufacturer's latest design. Specific equipment shown in schedules on drawings and specified herein is to be the basis for the Contractor's bid. Provisions for substitute equipment are outlined in the General Conditions. All materials shall be produced by manufacturing plants located in the United States of America.

B. All major items of equipment specified in the equipment schedules on the drawings shall be furnished complete with all accessories normally supplied with catalog items listed, and all other accessories necessary for a complete and satisfactory installation.

C. SHOP DRAWINGS: Prepare and submit in a tabbed, 3-ring binder shop drawings covering all equipment and materials to be used on this project. Include complete wiring and control diagrams. Submit the number of copies specified in the General Conditions and/or General Requirements of this specification within 45 days after award of contract.

1. Equipment must fit into the available space with allowance for operation, maintenance, etc. The Contractor shall take full responsibility for space and utility requirements for equipment installed.

D. MOTORS: Provide and install all motors as manufactured by Allis-Chalmers, Century, General Electric, Lincoln, Louis-Allis, Marathon, Reliance, U.S. Motors or Westinghouse. Each motor shall be designed and provided with nameplate for the electrical characteristics listed on the drawings. Electrical characteristics shall be verified with the job electrician before motors are ordered. Each motor shall be of the horsepower specified and shall be suitable for use at the project altitude. Motor criteria applies to factory built equipment as well as motors from local suppliers.

1. Open, drip-proof (ODP) three-phase motors shall be NEMA Standard, T-frame, rated for duty at the specified voltage plus or minus ten percent with a 1.15 service factor in a 40^{o} centigrade ambient condition, unless a higher ambient temperature is specified. Furnish with Class "F" or better internal insulations for project altitudes above 4500 feet elevation. Motors shall have cast iron housings, lubricable ball bearings with zerk fittings and grease relief fittings.

Motors shall be of drip-proof construction for general service unless otherwise specified. Motors shall be commercially dynamically balanced and tested at the factory before shipment.

2. Single phase motors shall be used for motors of one-half horsepower and smaller or as specifically indicated on the drawings. Motors shall have lubricable bearings, or permanently sealed where motor is normally inaccessible for regular maintenance, capable of handling thrust as may be imposed on the motor. Motors shall have a 1.15 service factor. Motors shall be permanent split capacitor unless noted otherwise.

3. All motors shall be rated for continuous duty.

4. Motors for V-belt drives shall be provided with cast iron or steel base with slide rail and adjustable screw device. The Contractor shall line up motors and drives and place motors and equipment on foundations ready for operation.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES:

A. The Contractor shall refer to other parts of these specifications covering the work of other trades which must be carried on in conjunction with the mechanical work, so that the construction operations can proceed without harm to the Owner from interference, delay or absence of coordination.

B. All chases and openings in walls and partitions shall be built by the General Contractor. This Contractor shall be responsible for the size and accurate locations of all openings and shall furnish the General Contractor adequate information covering his requirements as the job progresses.

C. Ceiling cavity space must be carefully coordinated with all trades; however, installation of mechanical equipment within the ceiling cavity space allocation, in the event of conflict, shall be in the following order: plumbing waste lines; supply, return and exhaust ductwork; fire sprinkler mains; domestic hot and cold water; and fire sprinkler branch piping and sprinkler runouts.

3.2 CUTTING AND PATCHING:

A. Mechanical and piping work shall be laid out in advance of building construction to permit building in pipe sleeves, inserts, hangers, supports, fixture carriers, etc., so as to eliminate unnecessary cutting of structural members. Where cutting becomes necessary, the Contractor shall employ the trade installing the work originally to restore such cut work and close openings communicating from one compartment to another at no expense to the Owner. Cutting the work of other trades shall not be done without the consent of the General Contractor. No structural member shall be cut without the written consent of the Architect. Wherever penetration of in-place

concrete is involved, this Contractor shall provide core drilling and concrete sawing as required to create the required openings. Openings shall be sleeved and sealed around pipe and duct.

3.3 QUALIFICATIONS OF WORKMEN:

A. All mechanics shall be capable journeymen, skilled in the work assigned to them. Apprentices may be used with appropriate direction.

B. No one unskilled in the work which he is given to do shall be employed, and all work shall be executed in a skillful and workmanlike manner. All men employed upon this work shall be competent, faithful, orderly and satisfactory to the Owner. Should the Owner's Representative deem anyone employed on the work incompetent or unfit for his duties, and so certify, Contractor shall dismiss him and he shall not be again employed upon the work without permission of the Owner's Representative.

C. FOREMAN: A full-time foreman shall be designated by the Contractor to the Owner's Representative and will be available on site for consultation. This individual, when appointed, shall not be replaced without prior approval from the Owner's Representative.

3.4 EXCAVATING AND BACKFILLING:

A. The Mechanical Contractor shall provide all excavation, trenching and backfilling for his underground piping. Excavation and backfilling shall be done in strict accordance with the applicable paragraphs of Specification Division 33. Bottoms of trenches shall be tamped hard and for soil and waste piping, shall be graded to secure uniform fall of 1/4" per foot, unless otherwise noted. Bell holes for sewer pipes shall be excavated so that pipe will rest on solid ground for its entire length. Sewer and water pipe shall be laid in separate trenches, except where otherwise noted.

B. After work has been tested, inspected and approved by the Owner's Representative and/or City Inspector, and prior to backfilling, the excavation shall be cleaned of all kinds of rubbish and backfill materials cleaned free of trash. Backfill shall be placed in horizontal layers not exceeding 12" in thickness and properly moistened. Each layer shall be compacted by suitable equipment to a dry density of not less than 95% as determined by the Modified AASHO Test T-180. See Division 33 for additional requirements.

C. The Contractor shall provide adequate shoring to safeguard workers from cave-ins for all excavations.

D. In areas where General Contractor has finish grade work to do, Mechanical Contractor shall backfill and compact to 8" below finish grade. Where no finish surface work is to be done, Mechanical Contractor shall backfill and match adjacent undisturbed surface with allowance for settling, etc.

E. The Contractor shall protect from damage all existing underground utilities indicated on the contract drawings (or field located for the Contractor by the Owner prior to

excavation operations). Any damage to identified existing utilities shall be repaired, at no cost to the Owner, by the Contractor.

3.5 PROTECTION OF MATERIALS AND EQUIPMENT:

A. Pipe and duct openings shall be closed with caps or plugs to prevent lodgement of dirt or trash during the course of installation. Equipment shall be tightly covered and protected against dirt, water and chemical or mechanical injury. Plumbing fixtures intended for the final installation shall not be used by the construction forces.

B. At the completion of the work, fixtures, equipment and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Owner's Representative. Damage and defects developing before acceptance of the work shall be made good at the Contractor's expense.

C. The Contractor shall not make temporary use of project equipment during construction without the consent of the Owner.

3.6 TESTS:

A. All tests shall be made in the presence of a Representative of the Owner, shall be recorded and certified by the Contractor and Representative. Local authorities shall be involved where required.

3.7 MANUFACTURER'S DIRECTIONS:

A. The Contractor shall install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the plans and specifications, the Contractor shall report such conflicts to the Architect, who shall make such compromises as he deems necessary and desirable.

3.8 LUBRICATION:

A. The Contractor shall be required to provide all oil for the operation of all equipment until acceptance. The Contractor shall be held responsible for all damage to bearings while the equipment is being operated by him up to the date of acceptance of the equipment. All motors and other equipment shall be provided with covers as required for proper protection during construction.

3.9 FLASHINGS:

A. All pipes penetrating the roof shall be flashed. Flashing shall be provided and installed by this Contractor after coordinating with the General Contractor. Provide curbs, flashings and counter-flashings and sealants. Make a durable weather-tight installation. Refer to drawings for additional detail.

3.10 ELECTRICAL WIRING AND CONTROL EQUIPMENT:

A. Motor starters, related control equipment and power wiring indicated on the electrical

drawings and control diagrams will be furnished and installed under the Electrical Division of this Specification. Items of electrical control equipment specifically mentioned to be furnished by the Mechanical Contractor, either in these specifications or on the electrical or mechanical drawings, shall be furnished and mounted by this Contractor and shall be connected under and as required by this Division and Electrical Division of these specifications.

B. The Mechanical Contractor must refer to the Control equipment and wiring shown on the diagrams. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the contractor furnishing the equipment.

C. The Mechanical Contractor must coordinate with the Electrical Contractor to ensure that all required components of the work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of coordination.

D. The Mechanical Contractor shall furnish, install and wire or have prewired all specified and necessary controls for package air conditioning units and other equipment specified for this project where the detailed electrical work is not shown on the electrical drawings. The requirement of this paragraph is to provide a complete operating system with no additional cost to the Owner for field wiring required integral to the equipment.

END OF SECTION

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SECTION 23 00 50
PLUMBING AND PIPING

PART 1 - GENERAL

1.1 GENERAL:

A. Conform with applicable provisions of the General Conditions, Special Conditions and the General Mechanical Requirements.

B. This section provides general information for all piping trades and subcontract areas and shall govern in the absence of specific direction to the contrary. Work includes utilities, plumbing, heating and cooling, refrigeration, special fluids, and miscellaneous piping.

C. Work covered in this section includes:
1. Piping Materials
2. Valves
3. Miscellaneous Equipment and Specialties
4. Joints
5. Installation
6. Tests

1.2 EQUIPMENT:

All plumbing, drains and connection stubs for Owner's fixtures shall be located, installed and made as indicated on the criteria drawing. Trenches, pits and conduits shall be of size and material indicated and located as required by plan.

1.3 GAS SERVICE:

Furnish new gas service and new gas meter set to serve new gas appliances, including rooftop units as required to insure complete installation. The contractor shall arrange and pay all fees for new meter set by the local gas company. Furnish and install new gas piping within the building to new equipment as indicated on the plans.

PART 2 - PRODUCTS

2.1 PIPING MATERIAL:

A. GENERAL:
1. The term "piping" as used herein includes pipe, tubing pipe, fittings, tubing fittings, strainers, specialties and accessory material that are a part of pipe and tube work.
2. Excessive cutting or weakening of structures to facilitate installation of piping will not be permitted; cut only as approved by Engineer.

B. IDENTIFICATION OF MATERIALS:

1. Prior to storing, identify pipe fittings and specialties at work site.
2. Piping fittings, specialty items and valves shall bear manufacturer's permanently affixed stamp or nameplate indicating manufacturer, catalog number, pressure and temperature rating, and other pertinent data.
3. Owner and Engineer reserve the right to reject piping items not readily identified as to construction details.

C. PIPING AND TUBING:

1. Shall have manufacturer's shop protective coating intact when delivered to work site and installed in work.
2. Minimum Pipe Size: 1/2" except for gauge piping.
3. Minimum Tubing Size: As specified by control and instrument manufacturers for minimum allowable pressure drop, and as approved by Engineer.
4. Pipe Material: Shall conform to ASTM and ANSI specifications and standards for service as shown in Sections 23 04 10 and 23 04 20.

D. PIPE FITTINGS:

1. Screwed Fittings:
   a. Tap to American Standard Pipe Threads, ANSI B2.1.
   b. Drainage pattern cast iron for waste and vent service.
   c. Threaded copper adapters as required.
2. Unions: Provide as shown on plans and as required for convenient dismantling and reassembling piping, at each branch line and equipment connection, and as required for convenient dismantling and reassembling bypass assemblies.
3. Hangers:
   a. General: Except as otherwise indicated, provide factory-fabricated horizontal piping hangers and supports complying with MSS SP-58, selected by Installer to suit piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use size of hangers and supports to exactly fit around piping insulation with saddle of shield for insulated piping. Provide copper-plated hangers and supports for copper-piping systems.
   b. Rigid piping system shall be supported regularly in such a manner that there is no strain placed on valves, flanged fittings, equipment, etc.
   c. Hangers for domestic hot piping may be installed inside of the insulation.
   d. Where pipes are installed adjacent to each other at the same elevation, the Contractor may use angle, channel iron or Unistrut shapes to make a trapeze hanger. Hanger rod loading shall not exceed the total loading indicated. Restrain piping in place on trapeze. Hanger rods shall be 3/4" minimum.
   e. Hanger rods shall be securely fastened to the structure. Do not thread hanger rods directly into expansion shields. Anchor an angle iron clip to the shield and secure the rod to the angle iron.
   f. Provide steel support from structure as needed for general support of suspended piping. Suspend from truss panel points. Coordinate with Structural Engineer. Review proposed installation with Engineer to verify adequate capacity.

4. Expansion and Contraction: The Contractor shall make all necessary provisions for expansion and contraction of piping with expansion joints, offsets or loops as required to prevent undue strain.
5. Anchors, Supports and Guides:
   a. Provide such anchors, guides, rollers and supports as may be required to securely anchor and guide piping in a manner prohibiting transmission of excessive forces on any piece of equipment, piping or structure.
   b. Arrangement and location of anchors, supports and guides subject to approval of Engineer.
   c. Double nut all bolts used to assemble anchors, supports and guides except Unistrut type supports to be bolted with fittings specified.
   d. Do not hang or support piping from other piping.
6. Pipe Sleeves:

   Pipe sleeves shall be furnished and set by the Contractor and he shall be responsible for their proper and permanent location. Sleeves shall be of standard weight steel pipe or not lighter than 16-gauge galvanized steel sheet.

   Pipe sleeves set in outside walls shall have a water stop ring. Such sleeves shall be of galvanized wrought iron or steel pipe, shall be not less than 1" inch or more than 2" inches larger in diameter than the pipe passing through. Space between pipe and sleeve shall be completely sealed by packing with oakum and caulking with Thiokol polysulfide rubber cement.

   Pipe sleeves through floor into wet rooms shall extend 1" above floor, be caulked and sealed.

   Sleeves through the floor into dry rooms shall be flush with the floor, caulked and sealed.

   Pipe sleeves shall allow for movement of the pipe due to expansion and contraction.

2.2 VALVES:

A. GENERAL:
1. Nameplate or markings on each valve shall show name of manufacturer or trademark, size, grade and pressure-temperature or service rating.
2. End bore shall match pipe bore to which connected.
3. Bronze valves by Chapman, Crane, Grinnell, Hancock, Jenkins, Lunkenheimer, Nibco, Nordstrum, Powell, Stockham, Vogt, Walworth, Watts.

4. Ball valves by Apollo, Nibco, Stockham, Watts.
5. Specialty valves as noted.
6. Swing Check Valves for Copper Pipe: Stockham B-309, 125 psi, bronze.
7. Ball Valves for Steel Pipe 2" and Smaller: 400 psi, packed valve stem. Apollo, Nibco, Watts.

B. INSTALLATION:

1. All valves shall be installed in locations which will allow easy operation and facilitate maintenance.

2.3 MISCELLANEOUS EQUIPMENT AND SPECIALTIES:

A. PRESSURE GAUGES: 4-1/2" diameter-face, Bourdon tube mechanism, brass case, glass cover, accuracy to 1/2 of 1% of scale range, range selected to place operating condition at approximately 75% of scale range. Ashcroft, Trerice, U.S. Gauge, Weksler, Marsh, or Marshalltown.

Provide snubber for water, gauge valve Crane No. 88 or Stockham B-22.

B. Vacuum breakers for culinary piping shall be furnished and installed at all points required by Plumbing Codes and local authorities. Typical locations include hose bibbs, wall hydrants, janitors sinks, lawn sprinkler systems, food service units, water makeup, and other similar conditions. Units shall be equivalent to Febco Series 710 or 715 and shall be accessible. Breakers mounted exposed in a finished room shall be chrome-plated.

C. STRAINERS: Y pattern, self cleaning, line size. Design to match copper pipe. Watts, Wilkins, Conbraco.

D. FLOOR, WALL AND CEILING PLATES (ESCUTCHEONS): Where exposed pipes pass through floors, finished walls or finished ceilings, they shall be fitted with chromium plated cast brass flanges with set screws. Plates shall be large enough to completely close the hole around the pipe, and shall be not less than 1-1/2" nor more than 2-1/2" larger than the diameter of the pipes or insulation. All plates shall be securely held in place.

E. DIELECTRIC/INSULATING FITTINGS: Insulating fittings shall be used to connect dissimilar metals (such as steel and copper) to prevent electrolytic action. Insulating fittings are not required between bronze valves and steel pipe or between copper coil headers and steel pipe.

1. Approved Manufacturers:
   a. ClearFlow “Dielectric waterway fitting”
   b. Engineer approved equal.

PART 3 - EXECUTION

3.1 GENERAL:

Provide and erect, in a workmanlike manner, according to the best practices of the trade, all piping and systems shown on drawings and required for the complete installation of these systems. The piping shown on the drawings shall be considered as diagrammatic for clearness in indicating the general run and connections, and may or may not in all parts be shown in its true position. The piping may have to be offset, lowered or raised as required or as directed at the site. This does not relieve the Contractor from responsibility for the proper erection of

systems or piping in every respect suitable for the work intended as described in specifications and approved by the Architect/Engineer.

In the erection of all piping, it shall be properly supported and proper provisions shall be made for expansion, contraction and anchoring of piping. All piping shall be cut accurately for fabrication to measurements established at the construction site.

Pipe shall be worked into place without springing and/or forcing, properly cleaning all windows, doors, and other openings and equipment. Cutting or other weakening of the building structure to facilitate installation will not be permitted. All pipes shall have burrs and/or cutting slag removed by reaming or other cleaning methods. All changes in direction shall be made with fittings. All open ends of pipes and equipment shall be properly capped or plugged to keep dirt and other foreign materials out of the system. Plugs of rags, wool, cotton waste or similar materials may not be used in plugging.

All piping shall be arranged so as not to interfere with removal and maintenance of equipment, filters, or devices; and so as not to block access to manholes, access openings, etc., provided in the piping of connections to all items of equipment, including refrigeration machines. All piping shall be so installed as to insure noiseless circulation. All valves and specialties shall be so placed as to permit easy operation and access, and all valves shall be regulated, packed and adjusted at the completion of the work before final acceptance.

All piping shall be erected to insure proper draining.

3.2 JOINTS AND EQUIPMENT CONNECTIONS:

A. GENERAL:
1. Do not peen, caulk or use any corrosive substance, gas fitter's cement, or "dope" to prevent leaks.
2. Joints to be watertight and airtight under test and operating pressures specified for various service.
3. Make joints in accordance with appropriate standard, unless otherwise specified.
4. Install piping with sufficient unions and flanged connections to permit convenient dismantling of equipment for maintenance.
5. Provide a valve and union as specified for type and class service near connection to main for each branch line.
6. Provide valve and union of proper type and rating in each piping connection at equipment.
7. Ream pipe ends after cutting.

B. SCREWED JOINTS:
1. Use threading dies which produce clean cut threads.
2. Ream interior of thread pipe ends and remove burrs and chips.

3. Clean and coat threads with thread lubricant, John Crane "Plastic Lead", Teflon Tape; apply to male thread only.

C. Hub and spigot type sanitary soil and vent piping shall be sealed by neoprene gaskets

by Ty-Seal or equivalent.

D. No-hub cast iron pipe joints shall conform to Cast Iron Soil Pipe Institute Standard 30165T.

E. SOLDER JOINTS: Tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned with steel wool before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connections. Joints for sweated fittings on water lines shall be made with a non-corrosive paste flux and no-lead solid wire solder, Silvabrite 100 or equivalent. Cored solder will not be permitted. Use "silfoss" silver bearing solder for brazing on below grade copper pipe, special fluids piping, refrigerant piping, etc.

3.3 INSTALLATION OF PIPING:

A. GENERAL:

1. Arrange as shown on Plans, or if modified from details shown on plans, arrange as approved by Engineer. Where not shown on Plans, arrange as approved by Engineer.
2. Accurately determine and cut pipe to required measurements; arrange for convenient operation, maintenance, repairs and replacement of component parts of system without necessity to dismantle adjacent and related work; work into place without springing or forcing; properly clear openings; install so there is no undue strain therein; anchor and provide for expansion. No additional compensation to be allowed for modification of piping to be in accordance with foregoing conditions.
3. Locate and arrange valves, fittings, specialties, and accessories so they will not drip on equipment or insulated surfaces if leaks develop therefrom. When this arrangement is not practicable, provide 22-gauge aluminum covers or guards turned up on ends; securely fasten in place to fully protect insulated and other covered and finished surfaces from water dripping or falling thereon.
4. Do not use short nipples, bushings or street-type fittings; mitered pipe to form elbows, notched pipe to form tees, or swage reducing pipe size, or piping supported from other piping. Use only fittings specified.
5. Piping Shown on Plans: Fabricate and erect as detailed, except where variations are required to suit equipment furnished or conditions requiring modification of details shown. No additional compensation will be allowed for modification of piping to suit equipment furnished.
6. Piping Not Shown on Plans: Field fabricate and erect to provide a workable arrangement with convenient access to valves and specialty items; arrange as approved by Engineer.
7. Piping Expansion: Provide adequate offsets and loops for piping not detailed on plans, as approved by Engineer; arrange as necessary to permit pipe expansion due to temperature change without producing excessive stresses therein, and for free movement of piping between anchors without binding.
8. Holes for Bolting: Drill holes; burning to enlarge holes not permitted.
9. Welding: Perform as necessary to complete work.
10. Nozzle Connections: Install nozzle fittings in shop; accurately cut openings in piping for nozzle fittings.
11. Pipe bends not acceptable; use pipe fittings to change direction of piping or to provide for pipe expansion.

12. Openings in Work: During installation, keep all equipment and pipe openings securely closed with bolted or approved type metal covers to keep water, debris, animals, birds, etc., out of work to avoid obstructions and drainage therein; close pipe ends at end of each shift, or when work is temporarily discontinued. In connection with insulated underground piping, keep pipe ends closed when work is not in progress.

B. PIPING ALIGNMENT AND GRADE (SLOPE): Applies to all piping.
1. Grade (slope) piping as shown on plans and as required to allow all pipe to drain completely. See section 23 04 20 for slope of waste piping.
2. Provide clearance around undetailed piping as required for application of insulation, repairs, and maintenance operations, and as detailed on drawings.

C. VALVES:
1. Install with stem horizontal or above.
2. Locate for convenient operation from floors or platforms.
3. Tighten glands as work is erected; add additional gland packing if required and retighten glands after valves are placed in operation and brought up to operating pressure and temperature.
4. Replace gland packings determined to be in deteriorated or unsatisfactory condition.
5. Install bypass piping and valves to be parallel and at the same centerline elevation as valve assembly bypassed; arrange piping so no interference or crowding will result due to bypass valves installed in this manner.

D. CROSS CONNECTIONS: No plumbing fixture, device or piping shall be installed which will provide a cross-connection or interconnection between a distributing water supply for drinking or domestic purposes and polluted supply, such as a roofage system or a soil or waste pipe which will permit or make possible the backflow of sewage, polluted water or waste into the water supply system.

E. CLEANING:
1. Rap and blow out piping and valves with compressed air before erection.
2. Completely remove temporary preservative coatings from valves and other piping accessories.
3. Thoroughly clean valves, specialties, and accessories of scale, solder chips and other deleterious substances; replace faulty and damaged packing and other equipment parts; adjust valves to give even flow.
4. Flush and drain systems prior to placing equipment in operation. Chemically clean as required.
5. Sterilize domestic water piping in compliance with Code.

3.4 TESTS:

A. Not less than 30 days prior to commencement of required testing operations, deliver to Engineer for his review a schedule that describes tests proposed.

B. Test piping prior to painting, insulating, closing insulated underground piping field closures, placing backfill, or other concealing operations in any manner in accordance with ANSI Code for Pressure Piping and, where specified, at pressures shown.

C. Provide facilities, including water test pumps, test plugs, blind flanges, pipe gauges, and valves. Provide piping connections and incidentals required for performance of tests.

D. Valve off, or otherwise isolate control, instruments, or other piping which may be damaged by test pressure.

E. Maintain test pressure in piping for not less than four (4) hours, unless shorter period is approved in writing by Engineer.

F. During testing, avoid pressure build-up due to solar effect. Provide relief valve set at specified test pressure to avoid pressures in excess of test pressures specified.

G. Test air and other piping in accordance with ANSI Code for pressure piping. Carefully examine joints during time test pressure is on pipe; check joints tested by air by coating with soapsuds solution; repair any leaks at test pressures indicated.

H. Do not commence painting, insulating, closing insulated underground piping field enclosures, placing backfill, or other concealing operations in any manner until piping has been tested by Contractor and proven free from leaks or imperfections.

I. Dispose of test water in a manner that will not result in damage or inconvenience to any property or persons. Flush piping out with water following tests.

J. Prepare report of tests; obtain signature of Owner's Representative.

END OF SECTION

SECTION 23 02 00
MECHANICAL VIBRATION AND SEISMIC CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. This section is Division 23 Mechanical Sound, Vibration and Seismic Control section, and is part of each Division 23 section making reference to mechanical vibration and seismic control specified herein.

C. Division 23 General Mechanical Requirements apply to work of this section.

1.2 SUMMARY:

Furnish and install complete seismic restraint and vibration control systems for all work installed under Division 23. Including owner furnished contractor installed equipment. Work to be responsive to the intent of the International Building Code, latest adopted edition, for the respective seismic zone.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Engage the services of an independent seismic and vibration control subcontractor who has the technology, experience, computer capabilities and manufactured products to prepare the required computations, shop drawings and special devices to meet the minimum requirements described herein. Select from the following:
1. Amber Booth
2. Kinetics
3. Mason

B. The seismic and vibration control subcontractor shall visit the site during construction at a minimum of two specific periods.
1. When equipment is set in place, prior to placement of seismic restraint devices for the purposes of directing the contractor in properly locating and installing the approved devices.
2. At the completion of the project, prior to final mechanical inspection, for the purpose of verifying the correctness of the seismic restraint and vibration isolation device installation and preparing certification of the seismic vibration-isolation work.

C. The seismic subcontractor shall exercise the quality control for this work and shall include, but not be limited to instructions direct to the Mechanical (Division 23) Contractor concerning:
1. Anchoring of all mechanical equipment including owner furnished and contractor installed.
2. Vibration mounting of equipment.
3. Equipment base coordination with restraint requirements.
4. Snubbing of equipment.
5. Bracing and anchoring of ductwork piping and conduit.
6. Provision for expansion and vibration of piping.

7. Concrete and/or steel pads or bases to assure proper mounting of restraints and isolators.
8. Vibration isolation of exhaust fans, relief fans, ventilation fans, and supply air fans.

D. The subcontractor shall be responsible for identifying the need for the size and location of steel sole plates and their attachment to structural steel or concrete.

E. The subcontractor shall certify in writing that he has inspected the installation and that all isolation, anchors and seismic restraint materials are installed correctly and functioning properly. Certification shall be provided after all corrective work has been completed.

1.4 SUBMITTALS:

A. Submittal data is required and shall consist of computations, vibration isolation selection, equipment anchors, anchor bolt sizes, supports, seismic restraints, sole plate data, restraint locations and type of restraints.

B. Submittal data shall identify dimensions, load deflection data, center of gravity, standard connections, manufacturer's recommendations, behavior problems including vibrations, thermal expansion, building expansion joints, etc., associated with equipment, ductwork, piping and conduit.

C. Calculations need not be submitted when restraint devices for piping, conduit and ductwork are proposed in accordance with the SMACNA Guidelines for Seismic Restraints.

D. Selection of isolator anchors and restraints shall be clearly made known along with the basis for selection so that proposed systems can be reviewed.

E. Calculations furnished for anchors, anchor bolts, sole plates and other support steel for restraining devices shall be signed and stamped by an engineer licensed in one of the United States.

1.5 REFERENCES:

A. Codes and Standards: (Latest adopted edition)
1. International Building Code
2. NFPA bulletin 90A,
3. UL Standard 181
4. Guidelines for seismic restraint of Mechanical Systems and Plumbing Piping Systems. Published by the Sheet Metal Industry Fund of Los Angeles, California, and the Plumbing and Piping Industry Council, Inc., Los Angeles, California.

PART 2 - PRODUCTS

2.1 MATERIALS - PRODUCTS:

Restraint devices shall be especially designed to resist seismic forces in all directions.

A. Piping, Conduit and Duct Restraints: Restraint materials for exposed installation shall be standard fabricated flat steel, angle rod and channel members.
1. Restraint members shall be bolt connected. Cabling materials and methods

shall be used only in chases or concealed ceiling spaces.

PART 3 - EXECUTION

3.1 SEISMIC RESTRAINT GUIDELINE:

A. Guidelines for SMACNA seismic restraints for conduit, piping and ductwork are to serve as the basis for restraint methods. (Exception - no cabling shall be used in the restraint systems except as noted.)

3.2 SEISMIC RESTRAINT-PIPING AND CONDUIT:

A. General: All piping and conduit shall be protected in all planes by restraints, designed to accommodate thermal movement while at the same time restraining seismic motion. Tanks and vessels connected to piping shall be restrained in the same manner as the piping.

B. Locations of the restraints shall include, but not be limited to:
1. At all drops or risers to equipment connections.
2. At all changes in direction of piping and conduit.
3. At all horizontal runs of pipe and conduit to keep it in alignment and prevent sagging with restraints not to exceed the following:
a. Transverse bracing at 40'-0" O.C. maximum.
b. Longitudinal bracing at 80'-0" O.C. maximum.
4. Provide flexibility in joints where pipes pass through building seismic or expansion joints.
5. On both sides of flexible connectors.

C. Exceptions:

1. Conduit under 2-1/2" size and piping under 1-1/2" size need not be additionally seismically restrained except as follows:
a. Brace all piping and conduit 1-1/4" and larger in boiler rooms, mechanical rooms, electrical equipment rooms and refrigeration machinery rooms.
b. Brace all fuel gas and oil piping, medical gas piping and compressed air piping 1" and larger.
2. Seismic bracing may be omitted:
a. When the top of the pipe is suspended 12" or less from the supporting structure member and the pipe or conduit is suspended by an individual hanger.
b. On all piping 3/4" and smaller.

3.3 SEISMIC RESTRAINT INSULATED PIPING:

Where piping is designated to be insulated, the points of support shall be protected by a 360o sheet metal shield. Insert insulation shall be of the same thickness as the adjoining pipe insulation. (Pipe Shields, Inc.)

1. The sheet metal shield wrapped around the insert shall be of the following lengths and gauge thickness.

PIPE SIZE	SHIELD LENGTH	MINIMUM GAUGE
1/2 - 1-1/2"	4"	20

2 - 6"	6"	20	
8 - 10"	9"	16	
12 - 18"	12"		16
20 and up	18"	16	

3.4 SEISMIC RESTRAINT - PIPING AT FIRE-WALL AND FLOOR PENETRATION WHERE WALL IS USED AS A RESTRAINT:

A. Bare Pipe: Encase pipe in minimum 24 gauge sheet metal can sized for one inch spacing between pipe and outer diameter of can. Spacing shall be packed in accordance with fire resistant/retardant materials in accordance with Section: FIRE STOPPING.

B. Insulated Pipe: Encase in adjustable or fixed length cans, minimum 24 gauge, sized for maximum one inch spacing between insulation and outer diameter of can. Insulation shall consist of 360° insert sized to extend a minimum of 1" beyond wall or floor penetration and of the same thickness as the adjoining insulation. Spacing between shield and can shall be packed in accordance with Section: FIRE STOPPING.

3.5 SEISMIC RESTRAINT - DUCTWORK:

A. Ductwork, four feet square and larger in cross sectional area or 26" diameter and larger shall be protected in all places by restraints. Locations shall include, but not be limited to:
   1. At all equipment connections.
   2. At all duct turns and duct run ends (transverse bracing).
   3. Transverse bracing to occur 30'-0" O.C. maximum. Rectangular ducts 61" and larger in either direction may be braced at 32'-0" O.C.
   4. Longitudinal bracing shall occur at 60'-0" O.C. maximum.

B. A group of ducts may be combined in a larger size frame using the overall dimensions with maximum weight for selection of restraint members.

C. No bracing is required if the top of the duct is suspended 12" or less from supporting member and attached at the top of the duct as well as sides and bottom.

3.6 SEISMIC RESTRAINT EQUIPMENT:

A. General: Furnish and install devices to isolate moving equipment from the structure and to seismic restrain it. Review isolation furnished with factory package equipment, require conformance with project criteria.
   1. Roof Mounted HVAC Units
   2. Roof mounted exhaust fans.

B. Field Verify: All required devices and installation.

3.7 VIBRATION ISOLATION - DUCTWORK AND PIPING:

A. Furnish and install devices to isolate all piping and ductwork from other moving equipment. Provide flex connections, spring hangers, grooved joint couplings for pipe, etc., as required.

END OF SECTION

SECTION 23 02 50
INSULATION

PART 1 - GENERAL

1.01 GENERAL MECHANICAL REQUIREMENTS:

The requirements of Section 23 00 00, General Mechanical Requirements, are a part of the work described in this section.

1.02 STANDARDS:

A. The work covered by this section of the specifications consists in furnishing all materials, equipment, skilled labor, appliances, supplies, services, construction plant, and in performing all operations in connection with the field insulation of the various mechanical components and systems, complete and in accordance with the specifications and drawings. Work covered by this specification includes:
   1. Pipe: Covering for domestic cold water and roof drain piping.

1.03 MATERIALS AND INSTALLATION:

A. GENERAL INSULATION CRITERIA:
   1. Insulation shall be as manufactured by Owens Corning, Fiberglass, PPG, Phillip Carey, Gustin-Bacon, Johns-Manville, Armstrong or approved equal, and shall be equal to that specified below. All insulation materials shall have a composite (insulation, jacket and adhesive) fire and smoke hazard rating not exceeding: Flame Spread - 25; Fuel Contribution - 50; Smoke Developed - 50. All accessories and materials used for fittings shall have same ratings. Information must be submitted to Architect by means of manufacturer's literature showing that the materials conform to above specifications without exception.
   2. Prefabricated or molded insulation shall be used on all fittings where applicable. Fitting covers shall be Zeston plastic covers or approved equal.
   3. All fittings, except as otherwise specified, shall be insulated with the same material and thickness as specified for the pipe.
   4. Unions, flanges and valves shall be insulated on cold water lines only.
   5. All piping shall be tested and approved before any insulation is applied.

B. Domestic water, waste, vent and drain piping shall be insulated with fiberglass one-piece preformed pipe insulation with all temperature jacket. All fittings and valves shall be finished with vapor barrier fitting mastic reinforced with fiberglass fitting tape and finished to a smooth surface, or with Zeston fitting jackets with joints sealed.
   1. Domestic cold water pipe insulation shall be 1" thick.
   2. All horizontal runs of interior above ground roof drain and secondary roof drain water piping shall be insulated with 1" thick fiberglass insulation. Insulate the exposed roof drain body below the roof deck.
   3. Plumbing vents within six lineal feet of roof outlet, shall be insulated with ½" thick fiberglass insulation.

END OF SECTION

SECTION 23 04 10
WATER DISTRIBUTION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SUMMARY:

A. This Section specifies the water distribution piping system, including potable cold and hot water piping, fittings, specialties and equipment within the building.

B. WATER SUPPLY SYSTEMS:
1. Domestic Cold and Hot Water and Domestic Recirculating Hot Water
2. Rough-in and Connect

C. RELATED SECTIONS:
1. Separate sections in Division 23 specify Basic Piping Materials and Methods, Hangers and Supports, Expansion Compensation, piping system identification materials and requirements, general duty valves, pipe insulation, and plumbing fixtures and equipment.

1.3 QUALITY ASSURANCE:

A. MANUFACTURER'S QUALIFICATIONS:
1. Firms regularly engaged in the manufacture of plumbing piping products and equipment of types, materials and sizes required, whose products have been in service for not less than five years.

B. INSTALLER'S QUALIFICATIONS:
1. Firms with at least three years history of successful experience on projects of similar nature.
2. Licensed as a firm in the Contractor state of origin and in the State of Utah.
3. Have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the Contractor.
4. All workmen employed on the project shall carry state licenses as journeyman or apprentice pipe fitters with additional certification for welders.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's technical literature indicating source, brand, type, model, performance characteristics, installation instructions, etc.

B. RECORD DRAWINGS: See Section 23 00 00.

C. OPERATION AND MAINTENANCE INFORMATION: Provide information for all equipment including a comprehensive system operating description.

1.5 REFERENCES:

A. CODES AND STANDARDS: Comply with applicable sections, follow recommended

practices.

1. International Plumbing Code
2. International Building Code
3. International Mechanical Code
4. ASHRAE/ASPE Handbooks

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Store pipe in a manner to prevent sagging and bending.

1.7 SEQUENCING AND SCHEDULING:

A. Coordinate the installation of pipe sleeves for foundation wall penetrations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. MANUFACTURER UNIFORMITY: Conform with the requirements specified in Basic Mechanical Requirements.

2.2 PIPE AND FITTINGS:

A. DOMESTIC WATER PIPE WITHIN BUILDING: (except below slab)
1. Pipe Sizes 3" and Smaller: Copper tubing. Conform to ASTM B88, Type L, hard temper, copper tube; ANSI B16.22 streamlined pattern wrought-copper fittings, with soldered joints using 95-5 tin-antimony solder or engineer approved press-fit joining system. Soldered joints shall conform to ASTM B-813 for flux type and use.

B. Domestic Water Pipe Below Slab/Grade:
1. Copper Tube: ASTM B 88 (ASTM B 88M), Type “K”, seamless water tube, annealed temper. Wrap piping with scotch wrap and then cover with 1/2" thick “Therma-cel” continuous. Set wrapped pipe in 3" sand or pea gravel all around.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Verify all dimensions by field measurements. Verify that all water distribution piping and equipment may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine rough-in requirements for plumbing fixtures and other equipment having water connections to verify actual locations of piping connections prior to installation.

C. Do not proceed until the unsatisfactory conditions have been corrected.

3.2 JOINING PIPES AND FITTINGS:

A. COPPER TUBING: Solder joints in accordance with the procedures specified in ASTM B828.

3.3 PIPING INSTALLATION:

A. Refer to the separate Division 23 section "Basic Piping Materials and Methods" and "General Requirements for Plumbing and Piping" for general piping installation instructions.

B. GENERAL LOCATIONS AND ARRANGEMENTS: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

3.4 FIELD QUALITY CONTROL:

A. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.

B. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

C. ROUGH-IN INSPECTION: Arrange for inspection of the piping system after system is roughed-in and before concealed or closed-in, and prior to setting fixtures.

D. FINAL INSPECTION: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.

E. REINSPECTIONS: Whenever the plumbing official finds that the piping system(s) will not pass the test or inspection, make the required corrections and arrange for re-inspection by the plumbing official.

F. Test for leaks and defects all new water distribution piping systems. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.

G. Leave uncovered and unconcealed all new water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.

H. Cap and subject the piping system to a static water pressure of 50 psig above the operating pressure without exceeding the pressure rating of the piping system materials. Isolate the test source and allow system to stand for a period of 4 hours. Leaks and loss in test pressure constitute defects which must be repaired.

I. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.

J. Prepare reports for all tests and list required corrective action and provide to Owner.

3.5 ADJUSTING AND CLEANING:

A. CLEANING AND DISINFECTING:

1. Purge all new domestic water distribution piping systems prior to use.

2. Follow AWWA guidelines. Thoroughly sterilize the entire domestic water system with a solution containing not more than 50 parts per million of available chlorine. Introduce the chlorinating materials into the system in a manner approved by the Owner's representative. Allow the sterilization solution to remain in the system for a period of 24 hours, during which time, open and close all valves and faucets several times. After sterilization, flush the solution from the system with clean water until the residual chlorine content is not greater than 0.2 parts per million. Water system will not be accepted until a negative bacteriological test is made on water taken from the system. Repeat dosing as necessary until such negative test is accomplished.

B. REPORTS:
1. Prepare reports for all purging and disinfecting activities and provide to Owner.

3.6 INSTRUCTION OF OWNER'S PERSONNEL: Participate in specified instruction. See Section 23 00 00.

END OF SECTION

SECTION 23 04 20
DRAINAGE AND VENT SYSTEMS AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and General provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SUMMARY:

A. This Section specifies building soil, waste and vent piping, including drains and drainage specialties, and equipment drain piping.

B. Remove all existing waste, drain and vent systems rendered obsolete by new work.

C. Related Sections:
1. Separate sections in Division 07 specify flashing and sheet metal and joint sealers.
2. Division 23 Basic Mechanical Requirements section applies to the work of this section.
3. Separate sections of Division 23 specify Basic Piping Materials and Methods, Hangers and Supports, Expansion Compensation, piping system identification materials and requirements, pipe insulation, and plumbing equipment.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications:
1. Firms regularly engaged in the manufacture of plumbing piping products and equipment of types, materials and sizes required, whose products have been in service for not less than five years.

B. Installer's Qualifications:
1. Firm with at least three years history of successful experience on projects of similar nature.
2. Licensed as a firm in the Contractor state of origin and in the State of Idaho.
3. Have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the Contractor.
4. Employ workmen on the project who carry state licenses as journeyman or apprentice pipe fitters with additional certification for welders.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer’s technical literature indicating source, brand, type, model, performance characteristics, installation instructions, etc. Color chart for finished surfaces and fixtures.

B. Record Drawings: See Section 23 00 00.

C. Operation and Maintenance Information: Provide information for all equipment including a comprehensive system operating description. See Section 23 00 00.

1.5 REFERENCES:

A. Codes and Standards: Comply with applicable sections, follow recommended practices.
1. International Plumbing Code with Amendments
2. International Mechanical Code with Amendments
3. International Building Code with Amendments
4. ASHRAE/ASPE Handbooks

1.6 SEQUENCING AND SCHEDULING:

A. Coordinate the installation of drains in poured-in-place concrete slabs, to include proper drain elevations, installation of flashing, and slope of slab to drains.

B. Coordinate with installation of storm sewer system as necessary to interface building drains with drainage piping systems.

PART 2 - PRODUCTS

2.1 WASTE, DRAIN AND VENT SYSTEMS:

A. Sanitary Soil Drain, Waste and Vent Piping:
1. Piping: To conform to the requirements of CISPI Standard 301, ASTM A-888 or ASTM A-74 and shall be cast iron soil pipe and fittings supplied by AB&I, Charlotte Pipe or Tyler Pipe.
2. Joints for Hubless Pipe: Hubless pipe and fittings joints shall conform to the requirements of ASTM Standard C-564 and Factory Mutual Standard 1680 and shall be heavy duty type 304 stainless steel full shielded couplings having 4 sealing clamps for pipe sizes 1 2@ thru 4" and 6 sealing clamps for pipe sizes 5" thru 15" as supplied by AB&I, Husky, Charlotte Pipe or Tyler.
3. Joints for Hub and Spigot Pipe: Hub and Spigot pipe and fittings joints shall be installed with compression gaskets conforming to the requirements of ASTM Standard C-564 as supplied by Charlotte Pipe or Tyler Pipe.
4. Schedule 40 galvanized steel pipe with drainage pattern cast iron screwed fittings (above ground only).
5. Below Slab PVC: Schedule 40 solid wall plastic pipe meeting requirements of ASTM D 2665 joined using cement primer meeting requirements of ASTM F 656 and Pipe cement meeting requirements of ASTM D 2564.
6. Above Grade: PVC Schedule 40 solid wall plastic pipe meeting requirements of ASTM D 2665 joined using cement primer meeting requirements of ASTM F 656 and pipe cement meeting requirements of ASTM D 2564. Do not install PVC piping in plenum spaces.
7. Fittings: PVC Schedule 40 solid wall plastic pipe fittings meeting requirements

of ASTM D 2665 joined using cement primer meeting requirements of ASTM F 656 and Pipe cement meeting requirements of ASTM D 2564.

8. Cleanout Plugs and Ferrules: Cleanouts shall be of the same size as pipe, except that cleanout plugs larger than 4" will not be required. Cleanouts installed in connection with cast iron soil pipe shall consist of a long sweep quarter bend or one or two eighth bends extended to an easily accessible place, or as indicated on the drawings. Floor cleanouts shall be Zurn Figure Z-1324, or equivalent Josam, Wade, or Smith, caulked into the hub of the fitting and finished flush with the floor. Where cleanouts are shown in connection with threaded pipe and are accessible, they shall be cast iron drainage T-pattern, 90-degree branch fittings with square head brass screw plugs of the same size as the pipe, up to and including 4". All outside soil, waste and drain lines shall have two-way cleanouts at all changes of direction.
9. Slope: New soil and waste piping to be installed with maximum slope available to connection with existing. Install beginning at low point.
10. Furnish and install identification tape a minimum of 6" above grease waste and sanitary waste pipe to clearly indicate service. Tape to be PVC type intended for bury.

2.1 ROOF DRAINAGE PIPING SYSTEMS:

A. Primary and Secondary Roof Drain Piping:

1. Piping: To conform to the requirements of CISPI Standard 301, ASTM A-888 or ASTM A-74 and shall be cast iron soil pipe and fittings supplied by AB&I, Charlotte Pipe or Tyler Pipe.
2. Joints for Hubless Pipe: Hubless pipe and fittings joints shall conform to the requirements of ASTM Standard C-564 and Factory Mutual Standard 1680 and shall be heavy duty type 304 stainless steel full shielded couplings having 4 sealing clamps for pipe sizes 1 ½" thru 4" and 6 sealing clamps for pipe sizes 5" thru 15" as supplied by AB&I, Husky, Charlotte Pipe or Tyler.
3. Joints for Hub and Spigot Pipe: Hub and Spigot pipe and fittings joints shall be installed with compression gaskets conforming to the requirements of ASTM Standard C-564 as supplied by Charlotte Pipe or Tyler Pipe.
4. Below Slab PVC: Schedule 40 solid wall plastic pipe meeting requirements of ASTM D 2665 joined using cement primer meeting requirements of ASTM F 656 and Pipe cement meeting requirements of ASTM D 2564.
5. Above Grade: PVC Schedule 40 solid wall plastic pipe meeting requirements of ASTM D 2665 joined using cement primer meeting requirements of ASTM F 656 and pipe cement meeting requirements of ASTM D 2564.
6. Fittings: PVC Schedule 40 solid wall plastic pipe fittings meeting requirements of ASTM D 2665 joined using cement primer meeting requirements of ASTM F 656 and Pipe cement meeting requirements of ASTM D 2564.

2.2 EQUIPMENT AND SYSTEM VENTS AND DRAINS:

A. Piping:

1. Piping on closed side of system to match primary system served.
2. Open vent and drain piping of Schedule 40 galvanized steel or Type K or L copper.

B. Installation Notes:
   1. Slope all drains at 1/4" per foot or more.
   2. Provide complete condensate drain systems for all air handling units, etc., for all equipment which has a need for such service.

      Terminate such drain systems near floor drains, floor sinks or other authorized point of discharge.

2.3 DRAINAGE PIPING SPECIALTIES:

A. Traps: Equip each fixture and piece of equipment connecting to the drainage system with a trap. Place each trap as near to the fixture as possible and no fixture shall be double trapped.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Verify all dimensions by field measurements. Verify that all drainage and vent piping and specialties may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Verify all existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.

C. Examine rough-in requirements for plumbing fixtures and other equipment having drain connections to verify actual locations of piping connections prior to installation.

D. Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.

E. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION FOR UNDERGROUND BUILDING DRAINS:

A. Grade trench bottoms to provide a smooth, firm, and stable foundation, free from rock, throughout the length of the pipe.

B. Remove unstable, soft, and unsuitable materials at the surface upon which pipes are to be laid and backfill with clean sand or pea gravel to indicated invert elevation.

C. Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand backfill. At each pipe joint, dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation.

3.3 JOINING PIPES AND FITTINGS:

A. Copper Tubing: Solder joints in accordance with the procedures specified in ANSI B9.1.

B. Cast-Iron Soil Pipe: Make, compression joints, and hubless joints in accordance with the recommendations in the CISPI Cast Iron Soil Pipe and Fittings Handbook, Chapter IV.

3.4 INSTALLATION:

A. Refer to the separate Division 23 section: Basic Piping Materials and Methods, for general piping installation instructions.

B. Install supports and anchors in accordance with Division-23 Basic Mechanical Materials and Methods section "Supports and Anchors."

C. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into account many design considerations. So far as practical, install piping as indicated.

D. Make changes in direction for drainage and vent piping using appropriate 45-degree wyes, half-wyes, or long sweep quarter, sixth, eighth, or sixteenth bends. Sanitary tees or short quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn tees where two fixtures are installed back to back and have a common drain. Straight tees, elbows, and crosses may be used on vent lines. Do not make a change in direction of flow greater than 90 degrees. Where different sizes of drainage pipes and fittings are connected, use proper size, standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

E. Install underground building drains to conform with the plumbing code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

F. Install building drain pitched at a minimum slope of 1/4" per foot (2 percent).

3.5 INSTALLATION OF PIPING SPECIALTIES:

A. Install flexible connection joints on roof drains.

B. Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:
   1. as required by plumbing code.
   2. each change in direction of piping greater than 45 degrees.

3. at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping.
4. at base of each vertical soil or waste stack.

C. Cleanout Covers: Install floor and wall cleanout cover for concealed piping, types as indicated.

D. Flashing Flanges: Install flashing flange and clamping device with each stack and cleanout passing through waterproof membranes.

E. Vent Flashing Sleeves: Install on stacks passing through roof, secure over stack flashing in accordance with manufacturer's instructions.

F. Vent Cap: Install on all vents terminating through the sidewall. Secure to vent.

3.6 INSTALLATION OF FLOOR DRAINS:

A. Install floor drains in accordance with manufacturer's written instructions and in locations indicated.

B. Install floor and area drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.

C. Trap all drains connected to the sanitary sewer.

D. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

E. Position drains so that they are accessible and easy to maintain.

3.7 CONNECTIONS:

A. Piping Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by the plumbing code.

B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

3.8 FIELD QUALITY CONTROL:

A. Inspections:
1. Do not enclose or cover drainage and vent piping system or put into operation until it has been inspected and approved by the authority having jurisdiction.
2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
3. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
4. Final Inspection: Arrange for a final inspection by the plumbing official to

observe the tests specified below and to ensure compliance with the requirements of the plumbing code.

5. Re-inspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for re-inspected by the plumbing official.
6. Reports: Prepare inspection reports, signed by the plumbing official.

B. Piping System Test:

1. Test for leaks and defects all new drainage and vent piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
2. Leave uncovered and unconcealed all new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
3. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
4. Prepare reports for all tests and required corrective action.

3.9 ADJUSTING AND CLEANING:

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Clean drain strainers, domes, and traps. Remove dirt and debris.

3.10 PROTECTION:

A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

END OF SECTION

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SECTION 23 04 35
FLOOR AND ROOF DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

B. Division 23, "General Mechanical Requirements" sections apply to work of this section.

1.2 SUMMARY:

A. This Section specifies plumbing fixtures and trim. The types of fixtures specified includes the following:
   1. Floor Drains
   2. Trench Drains
   3. Roof Drains
   4. Downspout Nozzles

1.3 SUBMITTALS:

A. Product Data: Submit Product Data and installation instructions for each fixture, specialties, accessories, and trim specified.

B. Maintenance Data: Include data in Maintenance Manual specified in Division 01 and Section 23 00 00.

1.4 REFERENCES:

A. Codes and Standards:
   1. State and Local Plumbing Code.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Store fixtures where environmental conditions are uniformly maintained within the manufacturer's recommend temperatures to prevent damage.

B. Store fixtures and Trim in the manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage to the fixture on trim.

1.6 SEQUENCE AND SCHEDULING:

A. Schedule rough-in installations with the installation of other building components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer uniformity shall be as specified in Section 23 00 00, “General

Mechanical Requirements" under "Project Options."

2.2 FIXTURES: See Plumbing Fixture Schedule for drain specifications.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine floors, and roof for suitable conditions where fixtures are to be installed.

C. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION:

A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings, and pertinent codes and regulations, the original design, and the referenced standards.

B. Comply with the installation requirements of ANSI A117.1 and Public Law 90-480 with respect to plumbing fixtures for the physically handicapped.

C. Fasten plumbing fixtures securely to supports or building structure.

3.3 FIELD QUALITY CONTROL:

A. Test fixtures to demonstrate proper operation upon completion of installation.

B. Inspect each installed unit for damage. Replace damaged fixtures.

3.4 CLEANING: Clean fixtures, using manufacturer's recommended cleaning methods and materials.

3.5 PROTECTION: Provide protective covering for installed fixtures.

END OF SECTION

SECTION 23 04 85
NATURAL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specifications sections, apply to work of this section.

B. Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.2 DESCRIPTION OF WORK:

A. Extent of natural gas systems work, is indicated on drawings and schedules, and by requirements of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of natural gas systems products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with natural gas systems work similar to that required for project.

C. Codes and Standards:
1. NFPA Compliance: Fabricate and install natural gas systems in accordance with NFPA 54 "National Fuel Gas Code".
2. Utility Compliance: Fabricate and install natural gas systems in accordance with the Local Gas Company regulations and recommended practice.
3. IFGC Compliance: Fabricate and install natural gas systems in accordance with ICC "International Fuel Gas Code".

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data and installation instructions for natural gas systems materials and products.

B. Record Drawings: At project closeout, submit record drawings of installed natural gas systems piping and products, in accordance with requirements of Division 01.

C. Maintenance Data: Submit maintenance data and parts lists for natural gas systems materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual; in accordance with requirements of Division 01.

PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS:

A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with NFPA 54 where applicable; base pressure rating on natural gas piping system maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in natural gas systems. Where more than one type of materials or products are indicated, selection is Installer's option.

2.2 BASIC IDENTIFICATION:

A. General: Provide identification complying with Division-23 Basic Mechanical Materials and Methods section "Mechanical Identification", in accordance with the following listing:
   1. Building Distribution Piping: Plastic pipe markers.
   2. Gas Service: Underground-type plastic line markers.
   3. Gas Valves: Plastic valve tags.

2.3 BASIC PIPES AND PIPE FITTINGS:

A. General: Provide pipes and pipe fittings complying with Division-23 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings", in accordance with the following listing:

B. Building Distribution Piping:
   1. Pipe Size 2" and Smaller: Black steel pipe; Schedule 40; malleable-iron threaded fittings (exposed), welded fittings and joints (concealed).
   2. Pipe Size 2-1/2" and Larger: Black steel pipe; Schedule 40; wrought-steel buttwelding fittings.

2.4 BASIC PIPING SPECIALTIES:

A. General: Provide piping specialties complying with Division-23 Basic Mechanical Materials and Methods section "Piping Specialties", in accordance with the following listing:
   1. Pipe escutcheons.
   2. Vandal-proof vent caps.
   3. Dielectric unions.
   4. Pipe sleeves.
   5. Sleeve seals.

2.5 BASIC SUPPORTS AND ANCHORS:

A. General: Provide supports and anchors complying with Division-23 Basic Mechanical Materials and Methods section "Supports, and Anchors", in accordance with the following listing:
   1. Adjustable swivel pipe rings for horizontal-piping hangers and supports.
   2. Two-bolt riser for vertical piping supports.
   3. Concrete inserts, C-clamps, and steel brackets for building attachments.

2.6 SPECIAL VALVES:

A. General: Special valves required for natural gas systems include the following types:
   1. Gas Cocks:

a. Gas Cocks 2" and Smaller: 150 psi non-shock WOG, bronze straightway cock, flat or square head, threaded ends.

b. Gas Cocks 2-1/2" and Larger: 125 psi non-shock WOG, iron body bronze mounted, straightway cock, square head, flanged ends.

B. Manufacturer: Subject to compliance with requirements, provide gas cocks of one of the following:
1. DeZurik Corp.
2. Jenkins Bros.
3. Lukenheimer Co.
4. NIBCO, Inc.
5. Powell (The Wm.) Co.
6. Rockwell International; Flow Control Div.
7. Stockham Valves and Fittings.

2.7 PRESSURE REGULATING VALVES:

A. General: Provide single stage, steel jacketed, corrosion- resistant gas pressure regulators; with atmospheric vent, elevation compensator; with threaded ends for 2" and smaller, flanged ends for 2-1/2" and larger; for inlet and outlet gas pressures, specific gravity, and volume flow indicated.

B. Appliance Regulators: Provide single stage, steel jacketed, corrosion- resistant gas pressure regulators; with vent to atmosphere, elevation compensator; with threaded ends. Regulators to be capable of reducing pressure from 5 lb service to 4 oz delivery pressure. Regulator to be listed for indoor use.

2.8 GAS METER:

New 2 lb. gas meter set to be provided by local gas company. Contractor to verify with local gas company and coordinate work. Contractor to pay any and all fees. Reference plans building design pressure.

PART 3 - EXECUTION

3.1 INSPECTION:

A. General: Examine areas and conditions under which natural gas systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF BASIC IDENTIFICATION:

A. General: Install mechanical identification in accordance with Division-23 Basic Mechanical Materials and Methods section "Mechanical Identification".

3.3 INSTALLATION OF NATURAL GAS PIPING:

A. General: Install natural gas piping in accordance with Division-23 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings".

B. Use sealants on metal gas piping threads which are chemically resistant to natural gas.

Use sealants sparingly, and apply to only male threads of metal joints.

C. Remove cutting and threading burrs before assembling piping.

D. Do not install defective piping or fittings. Do not use pipe with threads which are chipped, stripped or damaged.

E. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping, or equipment connection are completed.

F. Install drip-legs in gas piping where indicated, and where required by code or regulation.

G. Install "Tee" fitting with bottom outlet plugged or capped, at bottom of pipe risers.

H. Use dielectric unions where dissimilar metals are joined together.

I. Install piping with 1/64" per foot (1/8%) downward slope in direction of flow.

J. Install piping parallel to other piping, but maintain minimum of 12" clearance between gas piping and steam or hydronic piping above 200°F (93°C).

K. For piping underground beneath buildings, install in welded conduit. Extend conduit inside and terminate in accessible portion of building and seal. Extend conduit outside minimum of 4" from building, and vent above grade.

L. For piping running through ducts or air plenums, install in welded conduit, ventilated on both ends.

M. For risers running through concrete or asphalt, install through minimum 6" pipe sleeve. Fill annular space with gravel.

N. Install magnesium anodes for underground steel pipe, one 5-lb anode for up to 100' in length and one 5-lb anode for each additional 100'.

O. Install magnesium anodes for each underground steel or malleable- iron fitting, isolated between 2 sections of plastic pipe; one 3- lb anode for each fitting.

3.4 GAS SERVICE:

A. General: Arrange with local gas company to coordinate new meter set requirements. Consult with Utility as to extent of its work, costs, fees and permits involved. Pay such costs and fees; obtain permits.

B. Extend new 5 lb service piping from Utility's terminus to inside building wall, under Utility's direction.

3.5 INSTALLATION OF PIPING SPECIALTIES:

Install piping specialties in accordance with Division-23 Basic Mechanical Materials and Methods section "Piping Specialties".

3.6 INSTALLATION OF SUPPORTS AND ANCHORS:

A. Install supports and anchors in accordance with Division-23 Basic Mechanical Materials

and Methods section "Supports and Anchors".

3.7 INSTALLATION OF VALVES:

A. Gas Cocks: Provide at connection to gas train for each gas-fired equipment item; and on risers and branches where indicated.

B. Locate gas cocks where easily accessible, and where they will be protected from possible injury.

C. Control Valves: Install as indicated. Refer to Division 26 for wiring; not work of this section.

D. Pressure Regulating Valves: Install as indicated; comply with Utility requirements. Pipe atmospheric vent to outdoors, full size of outlet. Install gas shutoff valve upstream of each pressure regulating valve.

3.8 EQUIPMENT CONNECTIONS:

A. General: Connect gas piping to each gas-fired equipment item, with drip leg and shutoff gas cock. Comply with equipment manufacturer's instructions.

3.9 FIELD QUALITY CONTROL:

A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.

3.10 ADJUSTING AND CLEANING:

A. Cleaning and Inspecting: Clean and inspect natural gas systems in accordance with requirements of Division-23 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings".

3.11 SPARE PARTS:

A. Valve Wrenches: Furnish to Owner, with receipt, 2 valve wrenches for each type of gas valve installed, requiring same.

END OF SECTION

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SECTION 23 05 13
MOTORS

PART 1 GENERAL

1.1 SUMMARY

A. Includes But Not Limited To
   1. Quality of motors used in any and all mechanical equipment for Project.

B. Related Sections
   1. Section 23 0000 - General Mechanical Requirements
   2. Section 23 0515 – Variable Frequency Drives

1.2 SYSTEM DESCRIPTION

A. Design Requirements

   1. Provide motors which are nameplate rated for use at the project altitude.
   2. Guarantee motors to operate continuously at 115 percent of full nameplate load to 5600 feet elevation and at manufacturers altitude rating times 0.90 thereafter with temperature rise in any part not to exceed 40 deg C above ambient temperature.
   3. NEC compliant, premium efficiency type motor, unless noted otherwise.
   4. Motors scheduled for connection to variable frequency drives shall be inverter duty rated and nameplate indicated.

PART 2 PRODUCTS

2.1 MANUFACTURED MOTORS

A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.
   1. Motor torque characteristics shall be sufficient to satisfactorily accelerate the driven loads to operating speed within the time limits of the motor rating and of the starting equipment settings.
   2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range, or above 3300 feet elevation, will not cause the motor to operate above the manufacturer's motor rating for that altitude. Coordinate this requirement with the conductor and starting equipment sizing for each motor.
   3. Except for submersible pumps, motors shall be air cooled.
   4. Typically provide fractional horsepower, single speed, single phase motors (1/2 horsepower and less) of the permanent split capacitor type. (PSC) This requirement generally avoids motors of the shaded pole type.
   5. For motors 3/4 horsepower and larger, typically furnish polyphase squirrel cage type units.
   6. Furnish two-speed motors with 2 separate polyphase windings. Confirm 2-speed, 2-winding starter requirements with Division 26.

7. Temperature Rating: at a minimum, rate motors and motor drives for operation 40° C environment with maximum 90° C temperature rise for continuous duty at full load (Class H Insulation for altitude, Class B leads allowed).
8. Starting Capability: Frequency of starts as indicated by automatic control system, with not less than 6 evenly timed spaced starts per hour for manually or automatically controlled motors.
9. Service Factor: For sea level to 3300 feet elevation, 1.15 for poly-phase motors and 1.35 for single phase motors, 1.0 for TEFC motors. Note that above 3300 feet elevation, motor ratings typically de-rate the service factor from 1.15 to 1.0.
10. Provide pump motors with an end shield on the motor shaft and with ventilation openings beneath the motor.
11. Motor Construction: NEMA Standard MG 1, general Purpose, continuous duty, design "B", except "C" where required for high starting torque.
12. Frames: NEMA Standard No. 48 or 54; T-frame, use driven equipment manufacturer's standards to suit specific application.
13. Bearings:
    a. Ball or roller bearings with inner and outer shaft seals; for fractional horsepower, light intermittent/occasional duty motors, sleeve type bearings will be acceptable.
    b. Regreasable with zerk type and relief plug fittings, except permanently sealed where motor is normally inaccessible for regular maintenance. Lubricate motors at startup and then as recommended by manufacturer. Where sealed bearings are used, provide bearings with a nominal L10 – 100,000 hour life expectancy.
    c. Design bearings to resist thrust loading where belt drives or other drives produce lateral or axial thrust on the motor;
    d. Motors for use with variable frequency drives shall be inverter duty rated, premium efficiency. Motor bearings shall be electrically isolated from motor housing. Coordinate motor with Variable Frequency Drive supplier and equipment.
14. Motor Enclosure Type:
    a. Open drip-proof (ODP) motors for indoor use where they can be satisfactorily housed or remotely located during operation.
    b. Guarded drip-proof motors where exposed to contact by employees or building occupants.
    c. Weather protected type I for outdoor use, Type II where not housed.
    d. Cooling Tower duty rated for cooling tower applications.
    e. Totally enclosed, fan cooled (TEFC) for wet or dirty environments.
    f. Explosion Proof (EP) for hazardous rated environments.
15. Overload Protection: built-in thermal overload protection and, where indicated for large motors, internal sensing device suitable for signaling and stopping motor at starter.
16. Noise Rating: Provide motors which are "Quiet," within the sound power levels described by NEMA MGI-12.49, and which are commercially dynamically balanced at the factory.
17. Efficiency: Typically provide "Premium Energy Efficient" motors with a minimum efficiency as scheduled in accordance with IEEE Standard 112, test

method B. If an efficiency is not specified by the standard, motors shall have a higher efficiency than "average standard industry motors", in accordance with IEEE Standard 112. Motors used with Variable Frequency Drives shall be compatible and designed for use with Variable Frequency Drives and "Inverter Duty" rated. An "explosion proof" motor for classified areas, scheduled for use with VFD's, shall be listed for inverter duty applications.

18. Nameplate: indicate the full identification of manufacture: model, rating, characteristics, construction, special features and similar information.
19. Motors fitted with V-Belt or other tensioned drives shall have a cast iron or welded steel baseplate, with guided slide rails and adjustable screw tensioners, and rubber in shear bolt mountings.
20. Motor drives and couplings shall utilize shaft bushings to accommodate various shaft and drive diameters. Couplings shall be of the Browning Ever-Flex or Dodge "Para-flex" type, not a toothed gear with rubber insert (jaw) type.
21. Acceptable Manufacturers (subject to review on an individual application basis.)

a.	Baldor	e.	Reliance
b.	General Electric	f.	Siemens
c.	Lincoln	g.	Toshiba
d.	Magnetek	h.	U.S. Motors

PART 3 EXECUTION

3.1 INSTALLATION

A. Verify motor voltage characteristics with service voltage. Verify the motor horsepower rating to be adequate for the served load without intruding on the altitude motor service factor. Verify that the electrical provisions are adequate for each motor, i.e. conductor sizes, starting equipment size, overload protection, grounding, electrical bearing isolation, etc.

B. Place motors and equipment on foundations, align motors, couplings and drives and make ready for operation. Lubricate motor and related equipment bearings. Install zerks and relief plugs in the field if such are lacking on lubricable bearings. Adjust motors on bases to obtain proper belt tension. Check motor/equipment alignment and if needed, align motors, sheaves, couplings and driven equipment in the field. Work with electrician to verify direction of rotation. Make sure that there is no vibration in the operating assembly.

C. Clean motors and restore any damaged paint or finish. Protect nameplate from any painting.

END OF SECTION

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SECTION 23 05 15
VARIABLE FREQUENCY MOTOR DRIVES

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To
   1. Furnish and install variable frequency drive (VFD) systems matching with motors all as described in Contract Documents.

B. Related Sections
   1. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.
   2. Section 23 00 00 - General Mechanical Requirements
   3. Section 23 05 13 - Motors for HVAC
   4. Section 23 09 00 – Mechanical Control Systems
   4. Division 26 - Electrical

1.2 SYSTEM DESCRIPTION

A. VFDs shall be fully coordinated with the supplied motors individually provided or provided with the equipment required to be driven from VFD.

B. Design Requirements
   1. Variable Frequency Drive (VFD) System shall be solid state AC to DC converter sinusoidal pulse-width modulation (PWM) type.
   2. Unit shall operate on -
      a. Input Voltage (as specified; VAC), plus or minus 10 percent
      b. Input frequency 60 Hz, plus or minus 5 percent
   3. All components of system shall be contained in single enclosure as integrated package.
   4. Control power for operator devices and customer connections shall be 120 volts. Control power transformers shall be Machine Tool type and have primary and secondary fusing.
   5. Variable Frequency Drives shall be rated for continuous current equal to 105 percent of motor FLA.
   6. Rated overload current shall be 120 percent for one minute.
   7. Unit shall have adjustable accel / decel time setting from one second to 120 seconds.
   8. Unit shall maintain 95 percent or better displacement power factor over entire speed range.

1.3 QUALITY ASSURANCE

A. Requirements - Drive shall meet requirements of IEEE 519-1992 as measured at VFD system terminals.

B. Certifications - Completed unit including motor shall be UL or ETL listed and carry appropriate label.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Inspect unit for damage on delivery and then maintain unit in the factory shipping protection until the time of installation. Store unit in a weather protected area free of dirt, vibration, and moisture.

B. Do not allow unit to be exposed to excessive heat or cold.

1.5 SUBMITTALS:

A. Submit complete product and application information for variable speed drives as follows:
   1. Provide multiple sets of drawings of system (VFD) being supplied, in strict compliance with the specifications. Include, as a minimum:
      a. General arrangement of each unit showing size and incoming and outgoing conduit locations.
      b. Schematic diagrams and drawings.
      c. Connection diagram, sufficient to install drive system.
   2. Provide each unit with four owner/maintenance manuals which shall include:
      a. Vendor information of equipment being supplied.
      b. Connection information.
      c. Start up procedure.
      d. Fault reset instruction.
      e. Wiring diagrams (power and control).
      f. Parts list.
      g. Test results.
      h. Harmonic voltage distortion on line with unit off.
      i. Harmonic voltage distortion with unit on line.

B. Submit product data for motors, belts, drives, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections. Verify project electrical characteristics with submittal. Confirm suitability for altitude, maintaining full nameplate rating plus service factor. Include this data in maintenance manual in accordance with Section "Operation and Maintenance Manuals".

1.6 REFERENCES:

A. NEMA Standards MG 1: Motors and Generators.

B. NEMA Standards ICS 2: Industrial Control Devices, Controllers, and Assemblies.

C. NEMA Standards 250: Enclosures for Electrical Equipment.

D. NEMA Standards KS 1: Enclosed Switches.

E. Comply with National Electrical Code (NFPA 70).

1.7 WARRANTY:

A. General: For variable frequency drives. Furnish a written warranty consisting of the following:
   1. Warranty unit(s) with full parts and labor for five years after substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED VARIABLE FREQUENCY DRIVES

A. General: Furnish and install Variable Frequency Drives (motor speed controllers) with associated control signal components, harmonic filtering, power factor compensation and related cabinets, devices, ventilation, etc. Sizes and capacity as schedule on the drawings. Rate drives for constant torque (not variable torque) application with variable torque application capability. Drive shall be warrantied for parts and labor for 5 years after substantial completion. Drives shall be wired for full VFD rating.
   1. Verify compatibility of each VFD System being supplied with the related equipment motor. If a new motor is being supplied supply the VFD to match the new motor(s) and warranty the Drive to be compatible with that motor.
   2. Furnish each system in a NEMA 1, enclosure, wall-mounted or free standing as indicated, with louver covered exhaust ports, hinged doors, and painted with high grade enamel, fan forced, filtered ventilation. Door mounted operator devices shall be industrial grade, oil tight.
   3. Furnish each system with silk screened or engraved labels on all door operator and pilot devices, attached with screws, rivets or adhesive.
   4. Provide an electrical shock warning label on each system to warn personnel that a potential of electric shock exists.
   5. Supply each system complete, wired with all components assembled in a single enclosure including, but not limited to the VFD units, contactors, door interlocked circuit breaker. Units requiring mounting and interwiring of separate bypass enclosure are not under this specification.
   6. Supply a complete set of engineering drawings consisting of, as a minimum, general arrangement, power wiring diagram, control wiring diagram and schematic of VFD System components, options, and equipment and tests included to meet power quality requirements of the specification.
   7. Furnish an owner's manual consisting of catalog sheets showing actual components and parts numbers. Manual shall also show test certificates, warranty and service personnel responsible for warranty.
   8. Furnish factory trained VFD System installation and start-up and warranty service. Mount unit and connect to power supply, mount and wire remote devices.

B. Variable Frequency Drive Inverter
   1. Provide units which are derated for altitude and compensated and sized with allowance for capacity deration for elevation at which unit will be installed.

2. Provide units capable of operating in an ambient temperature range of 14 deg F to 122 deg F (-10 deg C to 50 deg C) and humidity of 0 percent to 90 percent noncondensing.
3. Mount VFD on a removable backpanel along with other components so that the VFD element itself can be removed from the assembly/enclosure for maintenance or part replacement, all while the unit runs in a bypass mode.
4. Output frequency clamp on drive for setting minimum or maximum output frequency.
5. Supply with door interlocked input disconnect motor circuit protector. Door mounted handle shall be able to lock in OFF position.
6. Rate drives for constant torque application with variable torque application capability.

C. Controls And Safety Equipment
1. Provide, as minimum, following door mounted operator controls -
   a. HAND / OFF / AUTO Switch
   b. Local / Remote Selector
   c. Frequency Setting Speed Selector
   d. Frequency Indication Meter Calibrated in Percent Speed
   e. Power on Light
   f. VFD / Bypass Switch
   g. VFD Fault Light
   h. External Fault Light (safeties interlock)
   i. Digital Keypad Programmable Parameter Unit
2. Provide minimum of following protective features with alarm display indication -
   a. Over-current shut-off
   b. Regenerative over voltage
   c. Electronic Thermal Protector
   d. Heatsink Overheat
   e. Instantaneous Power Failure
   f. Output Ground Fault (Actual phase to phase or phase to ground without damage)
3. Provide following termination points on terminal strip for field connections -
   a. Safeties Interlock
   b. Remote Start / Stop Contact
   c. Remote VFD Fault Contact
   d. Remote VFD / Bypass Enable Contact
   e. Remote Electronic Signal Input
4. Auto Restart shall be initiated by means of automatic time delayed restart after recovering from under voltage or loss of power. Inverter shall not automatically restart after over-current, over-voltage, over-temperature, or other damaging conditions, but shall require manual restart.
   a. Supply inverter with electro/mechanical or electronic bypass contactor arrangement for transfer VFD to feeder line to operate at constant base motor speed.
   b. Contactors shall be electrically and mechanically interlocked and supplied with adjustable motor overload relay.
5. Provide VFD isolation switch(es) to allow maintenance of VFD while operating in bypass mode. Prewired in same enclosure including contactors, input disconnect

MCP, motor overload, VFD / Bypass selector switch, and Bypass On light.

6. Provide elapsed time meter.
7. Frequency Jump - Supply drive with capability of being field programmed with frequency jump control to avoid operating at point of resonance with natural frequency of machine.
8. Provide drive with an AC line reactor.
9. Provide each VFD unit with Bacnet IP data card.
10. Fault Diagnostics - Drive system shall have non-volatile fault retention so VFDs fault history is available from memory even after power loss.

2.2 APPROVED SUPPLIERS

A. Acceptable Manufacturers: Acceptable manufacturers of VFD equipment shall meet the following requirements.

1. Suppliers of VFD Systems must be in the primary business of supplying Variable Frequency Drives and have a minimum of five (5) years of service in that business.
2. Vendor must have local service center with factory spare parts inventory and factory authorized service technician on call 24 hours/day.
3. VFD units supplied in response to this specification shall be labeled by UL, CSA or ETL. Note, the entire unit shall carry the label not just a component.
4. The following VFD suppliers are acceptable providing that all points of this specification are adhered to:
   a. ABB –
   b. Mitsubishi -
   c. Yaskawa -
   d. Toshiba International -
   e. Danfoss -
5. VFD vendors must have prior approval from Owner before quoting equipment specified. If not listed above, vendor must apply to Owner for approval 10 days prior to bid date showing point by point compliance with this specification including sample of typical harmonic voltage distortion test report. In compliance with general requirements of the specification.

2.3 SOURCE QUALITY CONTROL

A. Prior to shipping, test each unit and supply certified test report with each unit. Standard test shall include following.

1. Visual inspection consisting of checking unit enclosure, wiring, connections, fasteners, covers, and locking mechanism.
2. High Pot Test -
   a. Apply two times rated voltage plus 1000 volts AC for 60 seconds in accordance with UL 508 on all peripheral drive system power components (circuit breakers, contactors, motor overloads, line reactors, disconnect switches, etc) as complete package.
   b. Include copy of test results in operations manuals.
3. Test devices and lights on control panel devices.
4. Test optional equipment specified with VFD system.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Installation
   1. Vendor shall supply field start-up service by an authorized factory service representative consisting of system check-out, start-up and system run. The vendor shall provide warranty and authorized factory service including operator training. A written certificate of same shall be provided at start-up. Provide written certified start-up report. VFD service technicians shall be full time employees of the vendor or manufacturer, primarily engaged in VFD service work during normal business hours but on call 24 hours. Start-up by sales representative is not acceptable.
   2. Startup/adjustment effort shall have at least two segments.
      a. Prior to Test and Balance work to place equipment in operation.
      b. At conclusion of Test and Balance work to adjust units to actual operating conditions.
   3. Provide certificate of completion and authorized factory service including operator training and start-up.

B. The following adjustments and tests shall be performed as a minimum with certified copies included in the maintenance and operation manual.
   1. Verify that the input voltage is within the manufacturer's specification tolerances.
   2. Verify that the motor rotation is correct in all modes of operation.
   3. Verify all operator devices, programming and monitoring functions to be fully operational.
   4. Verify operation of all field signal control connections.
   5. Measure and record system output voltage and current at 50% and 100% speed. Tune the output voltage to correspond to motor nameplate rating at full speed. Check full load current measurements against nameplate data.
   6. Make all parameter adjustments to tune and optimize the VFD system to the application. Record all configuration values as part of this report.
   7. Conduct harmonic tests as identified in the specification. Measurements shall be recorded for each unit with the VFD system off, running at 50% speed, and running at full speed and load.

C. Testing
   1. VFD supplier shall provide three full spectrum harmonic analyses of VFD voltage and current waveforms for each VFD system.
   2. Harmonic report shall demonstrate operating harmonic waveforms with VFD's at 100 percent load, 50 percent load, and with motors operating across line.
   3. Harmonic tests shall be conducted at start-up and shall be performed in presence of Owner-
      a. Harmonic current distortion measured at VFD input terminals shall not exceed 40 percent of fundamental current drawn by VFD.
      b. Voltage distortion at this point shall not exceed 3 percent of fundamental.
      c. VFD suppler shall provide harmonic control devices to meet above requirements as integral part of ETL or UL listed VFD system.

d. Compliance with above limits is strictly responsibility of VFD supplier. Adjustments required to bring system to within specified limits shall be performed at no additional cost to Owner.
e. Harmonic tests shall be published and included in Operation and Maintenance Manual.
f. Harmonic distortion compliance shall be approved prior to final acceptance by Owner.

END OF SECTION

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SECTION 23 07 19
REFRIGERANT PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To
   1. Furnish and install insulation on above-ground refrigerant piping and fittings as described in Contract Documents.

B. Related Sections
   1. Section 23 23 00 - Refrigerant Piping and Equipment

PART 2 - PRODUCTS

2.1 MATERIALS

A. Flexible Foamed Pipe Insulation
   1. Thickness -
      a. 1/2 inch for one inch outside diameter and smaller pipe.
      b. 3/4 inch for 1-1/8 through 2 inch outside diameter pipe.
      c. One inch for 2-1/8 inches outside diameter and larger pipe (two layers of 1/2 inch.)
      d. One inch sheet for fittings as recommended by Manufacturer.
   2. Approved Products -
      a. AP Armaflex by Armacell
      b. Rubatex

B. Joint Sealer
   1. Approved Products -
      a. Armaflex 520 by Armacell
      b. BFG Construction Adhesive No. 105
      c. Rubatex R-373

C. Insulation Tape
   1. Approved Products -
      a. Armaflex AP Tape by Armacell
      b. R-180-FS Tape by Rubatex

D. Exterior Finish
   1. Approved Products -
      a. WB Armaflex Finish by Armacell
      b. Protective Coating 67x944 by Rubatex

2.2 MANUFACTURERS

A. Armacell, Mebane, NC (800) 232-3341 www.armaflex.com
B. BFG Industries, West Columbia, SC (800) 845-2220 or (803) 796-1380
C. Rubatex, Roanoke, VA 782-2839 or (540) 561-6000 www.rbxcorp.com

PART 3 - EXECUTION

3.1 INSTALLATION

A. General
1. Install insulation in snug contact with pipe and in accordance with Manufacturer's recommendations.
a. Insulate flexible pipe connectors.
b. Insulate thermal expansion valves with insulating tape.
c. Insulate fittings with sheet insulation and as recommended by Manufacturer.
2. Slip insulation on tubing before tubing sections and fittings are assembled keeping slitting of insulation to a minimum.
3. Do not install insulation on lines through clamp assembly of pipe support. Butt insulation up against sides of clamp assembly.
4. Provide 6 inch long, 20 ga galvanized steel sleeve around pipe insulation at each support. Extend insulation through pipe support clamps.
5. Stagger joints on layered insulation. Seal joints in insulation.
6. Install insulation exposed outside building so 'slit' joint seams are placed on bottom of pipe.
7. Paint exterior exposed insulation with two coats of specified exterior finish.

B. System Requirements
1. Condensing Units - Install insulation on above-ground refrigerant suction piping and fittings, including thermal bulb, from thermal expansion valve.
2. Split System Heat Pump Units - Install insulation on above-ground refrigerant liquid and suction piping and fittings.

END OF SECTION

SECTION 23 08 70
POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 General Mechanical Requirements sections apply to work of this section.

SUMMARY:

A. Extent of power and gravity ventilator work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of power and gravity ventilators specified in this section include the following:
   1. Power ventilators.
      a. Roof Mounted Exhaust Fans. (Dome type)

C. Refer to Division-23 section "System Commissioning, Testing and Balancing" for balancing of power and gravity ventilators; not work of this section.

D. Refer to Division-23 temperature control systems sections for control work required in conjunction with power and gravity ventilators; not work of this section.

E. Refer to Division-26 sections for the following work; not work of this section.
   1. Power supply wiring from power source to power connection on ventilators. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
   2. Interlock wiring between ventilators; and between ventilators and field-installed control devices as shown in Division 26.
      a. Interlock wiring specified as factory-installed is work of this section.

1.2 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of power and gravity ventilators, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's technical data for power and gravity ventilators, including specifications, capacity ratings, dimensions, weights, materials, accessories furnished, and installation instructions.

B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, construction details, methods of assembly of components, and field connection details.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to power ventilators. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are

factory-installed and portions to be field-installed.

D. Maintenance Data: Submit maintenance data and parts list for each type of power and gravity ventilator, accessory, and control. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 23.

1.4 REFERENCES:

A. Codes and Standards:
1. AMCA Compliance: Provide power ventilators which have been tested and rated in accordance with AMCA standards, and bear AMCA Certified Rating Seal.
2. UL Compliance: Provide power ventilators which are listed by UL and have UL label affixed.
3. NEMA Compliance: Provide motors and electrical accessories complying with NEMA standards.

PART 2 - PRODUCTS

2.1 ROOF MOUNTED EXHAUST / RELIEF FANS: (REF-1 thru REF-5, RAF-1)

A. General: Weatherproof dome type direct drive, size and capacity as scheduled on drawings. AMCA rated and labeled.

B. Up blast or down blast as scheduled on the drawings.

C. Heavy gauge spun aluminum housing, heavy gauge base, fan curb.

D. Aluminum alloy centrifugal non overloading fan wheel, backward inclined type, statically and dynamically balanced.

E. Heavy duty, self aligning ball bearings, grease lubricated, with zerk fittings.

F. Motor and shaft mounted on vibration isolators. Motor and components completely out of air stream. Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge containments.

G. Accessories: Bird screen, insulated sound curb to raise fan 12" above roof, automatic belt tensioning system.

H. Manufacturer: Subject to compliance with requirements, provide exhaust fans of one of the following:
1. Cook
2. Penn
3. Greenheck
4. Acme
5. Carnes
6. Briedert
7. Twin City

PART 3 - EXECUTION

3.1 INSPECTION:

A. General: Examine areas and conditions under which power and gravity ventilators are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF POWER AND GRAVITY VENTILATORS:

A. General: Except as otherwise indicated or specified, install power ventilators in accordance with manufacturer's installation instructions and recognized industry practices to ensure that products serve the intended function.

B. Coordinate ventilator work with work of walls, roof and ceilings, as necessary for proper interfacing.

C. Ductwork: Refer to Division-23 section "Ductwork." Connect ducts to ventilators in accordance with manufacturer's installation instructions.

D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted.

E. Remove shipping bolts and temporary supports within ventilators. Adjust dampers for free operation.

3.3 FIELD QUALITY CONTROL:

A. Testing: After installation ventilators has been completed, test each ventilator to demonstrate proper operation of unit at performance requirements specified. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

3.4 ADJUSTING AND CLEANING:

A. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

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SECTION 23 08 75
DIRECT FIRED HEATING AND VENTILATING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 SUMMARY:

A. Provide units with gas-fired heating and ventilating sections, designed and manufactured for outdoor installation. Units shall be packaged air handlers which include casing, modulating burner, non-overloading fan and controls for 100% outdoor air.

B. Refer to Division-26 sections for the following work; not work of this section.
1. Power supply wiring from power source to power connection on unit. Include required electrical devices, except where specified as furnished, or factory-installed by manufacturer.
2. Interlock wiring between electrically-operated equipment units; and between equipment and field-installed control devices shown on electrical drawings.
a. Interlock wiring specified as factory-installed is work of this section.

C. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections:
1. Control wiring between field-installed controls, indicating devices, and unit control panels.
2. Starters and Disconnects.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of packaged heating and ventilating units with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects with metal ductwork systems work similar to that required for project.

The Installer shall have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the contractor.
All workmen on the project shall carry state licenses as journeymen or apprentice sheet metal workers with additional certification for welders.

C. Factory Testing: Each heating and ventilating unit shall be factory-tested. Testing shall consist of checking all circuits for continuity, operability of all valves, control motors, fan speed, linkages, switches and burner. Each heating and ventilating unit shall be test-fired for minimum and high fire conditions. See "Fan and Motor" for additional fan testing requirements.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for heating and ventilating units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, gages and finishes of materials, and installation instructions.

B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, weight loadings, required clearances, construction details, and field connection details.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to heating and ventilating units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals.

1.5 REFERENCES:

A. Codes and Standards:
   1. American National Standards Institute (ANSI):
      (Establishes requirements applicable to certifying direct gas-fired heaters.)
   2. Standard Z83.18; Recirculating Direct Gas-Fired Industrial Air Heaters

B. American Society for Testing Materials (ASTM):
   1. Standard A653/653M; Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.

C. ETL Testing Laboratories, Inc. (ETL):
   1. Requirements applicable to product labeling and listing in the Directory of ETL Listed Products.

D. Factory Mutual Insurance (FM):

E. National Electrical Manufacturers Association (NEMA):
   1. Standard 250; Enclosures for Electrical Equipment

F. National Fire Protection Association (NFPA):
   1. Article 54; National Fuel Gas Code
   2. Article 70; National Electric Code
   3. Article 90A; Installation of Air Conditioning and Ventilating Systems

G. National Roofing Contractors Association (NRCA):
   1. The NRCA Roofing and Waterproofing Manual, Second Edition

H. Occupational Safety and Health Administration (OSHA):

I. Underwriters Laboratories, Inc. (UL):
   1. Standard UL916 Energy Management Equipment
   2. Standard UL873 Temperature Indicating & Regulating Equipment

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver air-conditioning units with factory-installed shipping skids and lifting lugs; pack components in factory-fabricated protective containers.

B. Handle air-conditioning units carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to air-handling unit manufacturer.

C. Store air-conditioning units in clean dry place and protect from weather and construction traffic. Where necessary to store outside, store above grade and enclosed with waterproof wrapping.

D. Comply with Manufacturer's rigging and installation instructions for unloading air handling units, and moving them to final location.

1.7 WARRANTY

A. The product shall have a manufacturer's limited warranty of at least 24 months, subject to the manufacturer's standard warranty limitations.

1.8 MAINTENANCE SERVICE

A. Provide service and maintenance for each air handler for one year from Date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. One set of Spare Filters.
   2. One set of Spare Belts.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering Direct Gas Fired Makeup Air Units that may be incorporated into the work include, but are not limited to:
   1. Cambridge
   2. Greenheck Fan Corporation.
   3. Captive Aire.
   4. Hastings.
   5. Econair.
   6. Trane

2.2 MANUFACTURED UNITS

A. Unit: Each Direct Gas-Fired Make-Up Air Unit shall be factory assembled and tested to assure proper alignment of subassemblies and proper adjustment and performance of controls. Heaters must be CSA certified to the Standard for Non-Recirculating Direct Gas-Fired Industrial Air Heaters, ANSI Z83.4/CSA 3.7-M99. Heaters shall be labeled as ASHRAE 90.1 compliant. Each Direct Gas-Fired Make-Up

Air Unit shall be manufactured for a rooftop application with horizontal mounting, configured with a discharge arrangement for down blast:

2.3 FABRICATION

A. Casing and Components: Galvanized steel panels, minimum 18 gauge; reinforced with a rugged integral frame. Hinged and/or latched access doors to burner, fan, controls and motor. Unit casing shall be configured with an end outdoor air opening and bottom discharge air openings to allow for a recirculating air flow arrangement.

B. Fan/motor Support: The fan/motor and bearings shall be supported by a reinforced structural steel framework independent of the cabinet with internal spring vibration isolation.

C. Access Doors: Doors shall be provided to allow easy service of all critical components, controls and fan.

D. Outdoor Installation: Units installed outdoors shall utilize weatherproof construction. Intake hood or plenum shall be used on horizontal units.

E. Lifting Points: Internal members shall be properly sized to allow rigging and handling of the unit from the top.

F. Finish: Standard finishes shall be a heavy-duty white powder-coat.

G. Observation Port: Provide on burner section for observing main and pilot flames.

2.4 BURNER AND GAS TRAIN

A. Burner: Line burner specially designed to burn natural or propane gas as indicated on the equipment schedule at or below the non-contaminating levels required by ANSI and OSHA. The burner shall have a cast iron manifold and heat resistant Type 430 stainless steel burner plates. The burner shall have a nominal turndown ratio and be designed for 100% combustion efficiency for the life of the equipment.

B. Burner Profile: The outdoor air velocity across the burner shall be controlled by fixed burner profile plates. The design of the unit profile plates shall maintain manufacturer's specified air velocity at all times over the burner during operation. No air from the occupied space shall be allowed to recirculate across the burner at any time.

C. Burner Assembly / Gas Train: The burner assembly and fuel piping arrangement shall include automatic ignition controls, UV scanner fame failure system, pressure regulator, fully modulating gas control valve with 25:1 turndown ratio, primary and secondary automatic shutoff valves and manual shutoff valve. Pilot gas controls shall include a pilot regulator, normally-closed solenoid shutoff valve, needle valve, and manual shutoff valve. Gas train shall be sized to provide full unit capacity at specified inlet pressure to the gas train. Provide and install a supplementary pressure regulator at each unit as necessary to maintain unit inlet pressure at less than 14" w.c.

D. Pilot: Electric spark ignition through a low voltage ignition transformer.

2.5 FAN AND MOTOR

A. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower and must have spring vibration isolation devices, minimum of 1 – 1/8 inches thick.

B. Fan: Belt driven, forward curve, fan statically and dynamically balanced, AMCA certified for air and sound performance.

C. Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating."

D. Fan/motor Bearings: Self-aligning, pillow block or flange type and shall have (for external static pressure less than 1" w.c.) an ABMA L10 rated life of 30,000 hours.

E. Motor: The motor shall be an ODP premium efficiency design with minimum service factor of 1.15, wired for the selected voltage, 1750 rpm, standard NEMA frame. Provide motor with factory wired motor starter with 2 normally open and 2 normally closed contacts.

F. Belt Drive: Motor pulleys shall be adjustable and shall be provided with static free belts.

G. Sound Power: The fan sound power shall not exceed 85 dBA at a distance of ten feet from the air handler discharge opening.

2.6 CONTROL SYSTEM

A. Factory Testing: The complete control system and all burner and gas manifold functions shall be factory tested for proper operation and to simplify field commissioning.

B. Control Enclosure: The unit control enclosure shall be constructed to NEMA 3R specifications with a hinged door. The control enclosure shall contain the gas train and all principal electrical components, such as motor, motor starter, fused disconnect switch, 120 V and 24 V transformers, control circuit fuses, control relay(s), circuit check lights, pressure transducer, flame relay and full number-coded terminal strip.

C. Flame Relay: The air handler control panel shall have a burner flame relay to lock out the fame in abnormal conditions.

D. Safety Controls
   1. High Gas Pressure: The high gas pressure switch, located on the burner end of the manifold, shall turn the burner of when the gas pressure is above its setpoint. The maximum gas pressure shall be set to 1" w.c. above the maximum high fire gas pressure.
   2. Low Gas Pressure: The low gas pressure switch, located on the inlet end of the manifold, shall turn the burner of when the gas pressure is below its setpoint. The minimum gas pressure shall be set at 7" w.c.
   3. Air Flow: The air flow switch measures air pressure differential across the burner to assure proper air flow during burner operation and prior to ignition. It shall be factory set at approximately 0.2" w.c. for the low setting and where applicable 1.4" w.c. for the high setting.

4. High Temperature Limit: A manual reset high temperature switch shall turn the burner of when air is discharged above its set point. The High Temperature Limit Switch shall be factory set at 160° F.

E. Conventional Electronic Controls System:
1. Temperature Controller: Provide amplifier with room temperature control, remote room or built-in temperature sensors and discharge air temperature sensor.
2. Pressure switch: Provide a null position pressure switch for controlling the mixing dampers.
3. Pilot Indicating Lights: Install UL labeled lights inside panel door (for outdoor air handlers) to indicate operation of control components as follows:
   a. Power on
   b. Low temperature limit switch
   c. Power to fan starter
   d. Fan on
   e. High temperature limit switch
   f. High gas pressure switch
   g. Low gas pressure switch
   h. Fan airflow switch
   i. Ignition
   j. Pilot valve
   k. Power to valves
   l. Power to temperature control
4. Remote Control Panel (One for Each Unit): Mount unit operating switches and pilot lights, as follows:
   a. Solid state temperature control system, including occupied and unoccupied switches and room temperature thermostats.
   b. Programmable electronic 7 day time clock with minimum of 4 on/off schedules per day and emergency battery power source with remote sensor
   c. Built-in burner reset control with remote vandal resistant temperature sensor where indicated.
   d. Burner alarm horn with silence switch.
   e. Pilot lights for Fan on/off, Burner on/off, Alarm on/off and Dirty Filter on/off.
   f. VENT/OFF/HEATING switch.

2.7 UNIT OPTIONS:

A. Roof Curb: Each air handler shall have a full perimeter, minimum 14" high curb formed of minimum 16-gauge galvanized steel as required to support the unit.

B. Inlet Opening: The inlet opening shall be provided with a weather resistant louver with drainable blades mounted on the outdoor air intake of the air handler and be constructed of steel with a baked enamel finish painted to match color of unit. Aluminum washable filters shall be provided on the inside face of the inlet louver.

C. Insulation: The unit cabinet shall be lined with 1", 1.5 lb density, neoprene coated, glass fiber insulation, which complies with UL181 for erosion and NFPA 90A for fire resistivity. The insulation shall be secured via adhesive and mechanical pin fasteners per SMACNA standards. All exposed edges shall be coated.

D. Filter Status Indication: Each filter section is provided with a differential pressure

switch and status indication.

E. Air Filter Section: outdoor air shall be filtered. All filters shall be changed from a single location.

F. Filters: 2" thick, pleated, MERV8, 30% filters. Farr 30/30 or equal.

G. Smoke Detector. An ionization type return air smoke detector shall be provided which shuts of the air handler if smoke is detected.

H. Remote Reset: A remote switch shall allow personnel to reset the burner.

I. Flame Relay: A self-checking UV scanner and diagnostic module.

J. Interlocking Relay: Provided for field interface with remote devices.

K. NEMA Starters: As required by equipment schedules, mounted in control enclosure (fed by the required main air handler disconnect).

L. Two Position Time Clock.

M. Freeze Protection.

N. Heat Inlet Sensor.

O. Service Receptacle.

P. Night Setback: Time Clock Control.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install equipment in strict accordance with manufacturer's instructions and in accordance with applicable governmental regulations by a contractor qualified in the installation of the manufacturer's product.

B. Install per NFPA 90A.

C. Install per NFPA 54 (ANSI Z223.1) by providing connection to fuel gas system.

D. Units which are shipped in multiple sections shall be assembled on the job site by the installing contractor. Assembly includes caulking all seams weather tight and extending electrical power and network control wires to the terminals provided, reconnecting the motor and control wiring between sections to create a complete and operable installation (per air handler manufacturer's recommendations).

E. Contractor shall extend pressure sensing tubes to inside and to outside of building as recommended by the air handler manufacturer.

F. Contractor shall provide a proper gas service drip leg and a lockable, lever handle manual shutoff valve. A high pressure regulator shall be installed if manifold pressure will exceed 1 psig.

G. Furnish Division 26 (Electrical) Contractor with field wiring diagram and electrical data to permit power wiring connections to the unit.

H. Installation contractor is to provide equipment check, test and commissioning in strict accordance with manufacturer's instructions.

I. Provide the owner’s operating personnel with instruction on proper use of the air handler and controls.

J. Contractor shall level the roof curb and install a cant strip and wood nailer per applicable details on the plans.

K. Install carbon monoxide / nitrogen dioxide sensors in the vicinity of the source contaminant (e.g., an operating vehicle), preferable at the breathing level of the occupants. Do not install sensors in confined ("dead") spaces.

L. The air handler shall be horizontal design as shown on the plans and designed to be supported by a roof curb as shown on the plans.

M. Installation shall take place within three months following date of shipment of product by manufacturer.

END OF SECTION

SECTION 23 09 55
MECHANICAL CONTROL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 General Mechanical Requirements sections apply to work of this section.

1.2 SUMMARY:

A. Extent of control systems work required by this section is indicated on drawings and schedules, and by requirements of this section.
   1. Control sequences are specified on the drawing.

B. Refer to other Division-23 sections for installation of dampers in mechanical systems.

C. Refer to Division-26 sections for the following work.
   1. Power supply wiring from power source to power connection on controls and/or unit control panels. Includes starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
   2. Interlock wiring between electrically-operated equipment units; and between equipment and field-installed control devices.
      a. Interlock wiring specified as factory-installed is work of this section.

D. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections:
   1. Control wiring between field-installed equipment, controls, indicating devices, and unit control panels.
   2. 120 volt service required by control systems.

E. Participate in "System Commissioning, Testing and Balancing".

1.3 QUALITY ASSURANCE:

A. MANUFACTURER'S QUALIFICATIONS: Firms regularly engaged in manufacture of electric control equipment, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. INSTALLER'S QUALIFICATIONS: Firms and workmen specializing and experienced in electric control system installations for not less than 5 years. Installer shall be under the direction of the controls manufacturer.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, and including installation instructions and start-up instructions.

B. SHOP DRAWINGS: Submit shop drawings for each control system, containing the following information:
   1. Schematic flow diagram of system showing fans, dampers and control devices, etc.
   2. Label each control device with setting or adjustable range of control.
   3. Indicate all required electrical wiring. Clearly differentiate between portions of work that are factory-installed and portions to be field-installed. Note contract responsibility to provide complete system regardless of delegation. Completely

interface with and show existing installation in the existing building.
4. Provide details of faces of control panels, including controls, instruments, and labeling.
5. Include verbal written description of sequence of operation. Confirm correct function of proposed sequences.

C. SAMPLES: Submit sample of each type of proposed thermostat cover.

D. MAINTENANCE DATA: Submit maintenance instructions and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Section 23 00 00.

1.5 REFERENCES:

A. CODES AND STANDARDS:
1. Electrical Standards: Provide electrical products which have been tested, listed and labeled by UL and comply with NEMA standards.
2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for electric control systems.
3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
4. Comply with NEPA 70, "International Electric Code" for all electrical installation.

1.6 DELIVERY, STORAGE AND HANDLING: Provide factory shipping cartons for each piece of equipment, and control device. Maintain cartons through shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protected from weather.

1.7 INSTRUCTION OF OWNER'S PERSONNEL: (See Section 23 00 00)

A. Purpose is to provide a transition of the systems from the Contractor to the Owner, leaving the Owner's personnel familiar with and well qualified to operate and maintain the systems.

B. Instruction to cover purpose and function of each system and its components, to show proper operating technique, to show proper maintenance technique.

C. Prepare an outline of information to be conveyed, list materials available for reference. Submit to Architect along with a proposed schedule of instruction. Schedule to allow individual time for each trade and each system.

D. Convey information in formal classroom session. Teachers to include qualified contractor personnel and sales representatives for each major piece of equipment. Go from the classroom to the actual location to graphically illustrate concepts discussed.

1.8 WARRANTIES:

A. As part of the overall project warranty, furnish individual manufacturer warranties for each piece of equipment for a period of not less than one year from date of Owner's beneficial use (substantial completion). Though some systems will be activated and functioning, warranty does not go into effect until final completion of the building and acceptance by the Owner.

B. Warrant the overall assembly of equipment, materials and labor comprising these systems.

1.9 CLEANING AND LUBRICATION: All instruments, control panel and control piping shall be thoroughly cleaned before final acceptance. Provide lubrication for all furnished equipment.

1.10 TESTING AND ADJUSTING OF SYSTEM:

A. During the system commissioning, testing and balancing of the various building

systems, have a controls representative(s) present and available to interpret and adjust controls as needed. Demonstrate and report the integrity and accuracy of each function and control point.

B. At the termination of the testing period, the Controls representative shall spend one working day instructing the Owner's operating personnel in the control system operation, and one working day checking each system for day-night and manual override with the Owner's operating personnel on each air system. A complete operating booklet shall be provided and used during the training period. Schedule this training with the Owner and Mechanical Contractor.

Since system performance is partly a function of climatic conditions, the Controls contractor shall be available during the changing seasons of the warranty period to make further adjustments and modifications if required. A final complete check of all systems shall be made at the conclusion of the one year warranty period.

PART 2 - PRODUCTS

2.1 CONTROL CABINETS: Furnish stamped steel with hinged door and locking latch control cabinets to protect and conceal all control devices. Arrange components neatly to provide adequate maintenance opportunity and proper device function. Label all components, numerically code all piping and wiring. Terminate all wiring at terminal blocks. Provide engraved plastic labels for all panel face devices.

A. Provide with surge suppressor - one per panel.

B. Provide with 120/60/1 duplex outlet - one per panel.

C. Provide with fuse - quantity as required.

D. Provide with transformer 120/24 VAC quantity as required.

E. Provide RS-232 service trunk from main panel into each ATC panel for "Laptop" computer access.

2.2 CONTROL DAMPERS:

A. In supplying dampers, instruct the sheet metal (Section 23 08 00) workers in the proper installation of the dampers. Ductwork shall be reinforced and the damper properly supported without strain.

B. Protect all dampers mounted in a duct system which requires special treatment.

C. Provide damper operators with diaphragms or motors of proper size, so that the motors will operate against the static pressure of the systems. Provide each damper motor with a bracket for attaching to ductwork, building structure or equivalent. Damper motors in plenums shall be mounted on damper frames. Do not install motors in ducts. Modulating motors where indicated shall be provided with integral stops for both minimum and maximum stop.

D. Control dampers for outside air and relief air exposed to weather temperatures in built-up systems. Low leakage type with spring loaded side seals, inflatable butyl or neoprene fabric edge seals, bronze or teflon bearings, reinforced galvanized steel blades. Parallel action. Air leakage not to exceed 10 CFM per square foot at 4" upstream static pressure.

Johnson "Proportion-Aire" D-1200/D-1300.
Ruskin CD50
Greenheck VCD-43

E. ELECTRIC DAMPER ACTUATORS:

1. Electronic direct-coupled actuation shall be provided. The actuator shall be fastened to the damper shaft via a clamp assembly of a "V" bolt design, with associated "V" shaped toothed cradle. Where required for power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operations shall not be acceptable. All spring return actuators shall be capable of clockwise or counterclockwise fail safe operation by changing the mounting orientation. Where direct-couple mounting is not feasible, provide factory cataloged brackets, mounting kits, and hardware.
    a. The actuator shall be UL Standard 873 listed. The actuator shall be have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch protection shall not be acceptable. All 24 VAV/VDC actuators shall operate on Class 2 wiring, and shall not require more than 10 VA for AC, or more then 8 watts for DC applications. Two-position spring return actuators operating on 120 VAC shall not require more than 10 VA. Actuators shall be provided with a conduit fitting and a minimum 3 foot electrical cable, and shall be pre-wired. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque, and shall have a 2 year unconditional manufacturer's warranty.

2.3 ELECTRICAL POWER SUPPLY:

A. Obtain power from existing Division 26 panel. Furnish appropriate circuit breakers and extend conduit and wiring assigned to this division.

B. Furnish and install UL listed voltage reducing transformers required for this work. Size transformers to see no more than 70 percent of rated capacity at full load.

C. Make all electrical installations in conformance with the National Electrical Code (current edition) and in accordance with Division 26.

D. Use same product lines for similar devices as used by Division 26 00 00 to result in a coherent project.

E. Control Wiring
    1. In future concealed locations above lay-in ceilings low voltage conductor may be installed without conduit. Low voltage conductor shall be UL listed Article 725 Plenum Cable. Install the cable parallel to building walls.
    2. In all other building areas and above future 'hard' ceilings, within walls, etc., all control wiring shall be installed in conduit per International Electric Code. Installation shall be square with the walls of the buildings.
    3. Number and code all wiring.

F. Use no wire smaller than 12 gauge, no conduit smaller than 3/4".

2.4 SMOKE DETECTORS: For installation in the supply air discharge of all fan systems above 2,000 cfm. Factory wired by the Heating and Ventilating Unit manufacturer, Power and fire alarm wiring by Division 26 00 00, control circuit alarm contact by this Division.

2.5 AUXILIARY RELAYS:

A. Light Duty - as required.

B. Heavy Duty - Square D, Class 8501, Type X.

C. T-E, S & S.

PART 3 - CONTROL SEQUENCES

3.1 GENERAL:

A. Provide control systems to manage and manipulate mechanical equipment in a functional and energy conserving way.

B. Provide control panels in locations as indicated on the drawings with terminal block connections for interface of heating and ventilating units, etc.

3.2 HEATING AND VENTILATING SYSTEM CONTROL SEQUENCE (HVU-1, HVU-2, HVU-3, RAF-1, MD-1, MD-2 and MD-3):

A. Each heating and ventilating unit (HVU) shall be provided with a remote control panel with a vent-off-heating-switch, electronic thermostat and a space temperature selector switch furnished by the HVU vendor and installed by Division 23.

B. Each rooftop relief air fan shall be provided with a built-in electrically commutated (VFD) motor with hand-off-auto switch.

C. Each heating and ventilating unit runs continuously in heating or ventilating mode.

D. For each heating and ventilating unit, when the vent-off-heating switch is in vent mode, the heating and ventilating unit supply fan shall run continuously. The respective unit's burner shall be disabled.

E. For each heating and ventilating unit, when the vent-off-heating switch is in heating mode each heating and ventilating unit supply fan shall run continuously and the related temperature controller shall then send a signal to modulate the related heating and ventilating unit gas valve which in turn shall vary the discharge temperature as needed to maintain the local space heating set point temperature of 65°F (adj.) as monitored by a remote or built-in space temperature sensor. Another remote temperature sensor is also provided to monitor the local space temperature at a higher level as a check for stratification. Set the discharge temperature high limit at 95°F (adj.).

F. When heating and ventilating unit HVU-1 or heating and ventilating unit HVU-2 is running, its respective outside air damper shall open and outlet dampers MD-1, MD-2 and MD-3 shall also open.

G. When heating and ventilating unit HVU-1 or heating and ventilating unit HVU-2 is off, it's related outside damper shall close.

H. When both heating and ventilating unit HVU-1 and heating and ventilating unit HVU-2 are off, it's related outside dampers shall close and outlet dampers MD-1, MD-2 and MD-3 shall close.

I. When heating and ventilating unit HVU-3 is running, its outside air damper shall open. Rooftop relief fan RAF-1 shall also be enabled to run at its balanced speed and Each rooftop relief fan's damper shall open.

J. Each rooftop relief fan shall be balanced to match the air flow of heating and ventilating unit HVU-3.

K. When heating and ventilating unit HVU-3 is off, its related outside damper shall close. Rooftop relief fan RAF-1 shall also be enabled to shut off and Each rooftop relief fan's damper shall close.

L. When unusual conditions occur, each heating and ventilating unit shall be shut off by the building fire alarm system or by each unit's own safety controls.

3.3 ROOFTOP UNITS CONTROL SEQUENCE (RTU-1, RTU-2):

A. Each rooftop unit is controlled from a wall mounted thermostat.

B. On call for cooling, each rooftop unit supply fan shall be activated to run through its factory provided motor starter to maintain the cooling discharge temperature low limit set point of 55°F (adj.) and satisfy the cooling demand. If the outside air temperature is favorable operate each rooftop unit in economizer mode. When the economizer function can no longer satisfy the cooling demand, stage each the rooftop unit's compressors on in a sequential manner until all compressors are running as needed to satisfy the cooling demand. When the outside air temperature rises above 75°F (adj.) the unit's outside air damper shall modulate to minimum position.

C. On call for heating, each rooftop unit supply fan shall be activated to run in order to maintain the high limit temperature of 95°F (adj.). The outside air damper for each rooftop unit shall be at minimum position. The respective unit's heating system shall be enabled through its two stages of heating in order to satisfy the heating demand.

D. Each rooftop unit's minimum outside air position shall be set as indicated on the Rooftop Unit Schedule in order to maintain the local space static of .05" SP (adj.).

E. Each rooftop unit's barometric relief damper modulates as needed to maintain the space differential pressure set point of .05" SP (adj).

F. When the unit supply fan is off or during unoccupied mode, the outside air damper shall be closed, the return air damper shall be open, and the unit's cooling function will be off. On call for heating the unit's supply fan shall run at the balanced speed and the unit's heating function shall be enabled through its two stages as needed to maintain the night setback temperature set point of 65°F (adj.).

G. Each rooftop unit shall shutdown should unusual conditions occur as monitored by the units own safety controls or from a unit mounted duct smoke detector on unit through the Building Fire Alarm.

3.4 GAS FIRED UNIT HEATER (UH-1):

A. The gas fired unit heater operates through its own controls after all safeties are met to provide heating to the local space when the local space temperature drops below set point of 65°F (adj.) as monitored by a wall mounted thermostat.

3.5 SPLIT AIR CONDITIONING UNIT (SAC-1, SCU-1):

B. The split air conditioning unit operates through its own controls after all safeties are met to provide cooling to the local space when the local space temperature rises above set point of 80°F (adj.) as monitored by a wall mounted controller with built-in space sensor.

3.6 ELECTRIC CABINET HEATER (ECH-1):

C. The electric cabinet heater operates through its own factory wired controls to provide heating to the local space when the local space temperature drops below set point of 65°F (adj.)

3.7 ROOFTOP EXHAUST FANS (REF-1 thru REF-5):

A. Each rooftop exhaust fan shall be provided with a hand-off-auto switch with indicator light by Division 23.

B. In hand mode each rooftop exhaust fan shall run continuously.

C. In auto mode rooftop exhaust fans REF-1 and REF-5 shall be enabled to run from separate wall mounted local switches.

D. In auto mode rooftop exhaust fan REF-2 shall be enabled to run from a wall mounted chlorine gas detector when chlorine gas is detected above an allowed level with bypass

switch.

E. In auto mode rooftop exhaust fans REF-3 and REF-4 shall be enabled to run from separate wall mounted thermostats, when the local space temperature rises above set point temperature of 80°F (adj.) with bypass switches.

F. The speed of each rooftop exhaust fan shall be set through its respective electrically commutated motor.

G. When any rooftop exhaust fan runs, its related motorized damper shall open.

3.8 CEILING EXHAUST FAN (CEF-1):

A. The ceiling exhaust fan shall be interlocked to run from the local light switch. Wiring by Division 26.

END OF SECTION

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SECTION 23 23 00
REFRIGERATION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL MECHANICAL REQUIREMENTS:

A. All pertinent sections of Section 23 00 00 - General Mechanical Requirements are a part of the work described in this section.

1.2 SUMMARY:

A. This section specifies:

1. Refrigeration piping systems and equipment for split air conditioning systems.
2. Piping, valves, specialties.

1.3 STANDARDS:

A. International Building Code/International Mechanical Code

B. Local Codes and Ordinances

C. State Pressure Vessel Regulations

D. EPA Requirements.

1.4 SHOP DRAWINGS/SUBMITTALS:

A. Submit a list of all materials to be used indicating brand or source, type and service.

B. Submit shop drawings for all equipment, valves and specialties, including shop drawing showing proposed pipe routing, sizing, valving, etc.

1.5 CONTRACTOR QUALIFICATION:

A. The Piping Contractor for this work shall be licensed as a firm in the Contractor state of origin and in the state where the work is performed.

B. The Contractor shall have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the Contractor.

C. All workmen employed in the project shall carry state licenses as journeyman or apprentice pipe fitters with additional certification for welders.

1.6 SCOPE OF THE WORK:

A. Furnish and install all field fabricated refrigeration systems and related work to effect a complete installation.

1. Provide and install complete refrigeration piping systems and equipment for split air conditioning systems as indicated in the Contract Documents and as specified in this section. Make systems fully operational.
2. Piping, valves, specialties.
3. Other work indicated on the drawings.

1.7 INSTRUCTION OF OWNER'S PERSONNEL:

A. Purpose is to provide a transition of the systems from the Contractor to the Owner, leaving the Owner's personnel familiar with and well qualified to operate and maintain the systems.
B. Instruction to cover purpose and function of each system and its components, to show proper operating technique, to show proper maintenance technique.

1.8 WARRANTIES: See Section 23 00 00.

PART 2 - MATERIALS AND METHODS

2.1 EQUIPMENT: All major items of refrigeration equipment shall be as specified in the equipment schedules on the drawings and shall be furnished complete with all accessories normally supplied with the catalog item listed and all other accessories necessary for a complete and satisfactory operating system.

2.2 PIPING MATERIALS: Piping materials shall be as follows unless otherwise indicated on the applicable contract drawing:

A. Pipe: "ACR" Type L, hard drawing, degreased, sealed at mill copper tubing, ASTM B88-62, cleaned and sealed at the mill. Pre-charged refrigerant lines shall not be used.

B. Fittings: Long radius, wrought copper type equal to Mueller Streamline, ASA B16.22.1963.

2.3 VALVES, SPECIALTIES, ETC:

A. Filter-Dryer: On lines smaller than 3/4" O.D. filter-dryer shall be a sealed type using male flare fittings. Size shall be full line size. Filter-dryer shall be Sporlan, Mueller or Alco.

B. Sight Glass: Shall be a combination moisture and liquid indicator with protection cap. Sight glass shall be Alco, Mueller, Sporlan or Henry. Size shall be full line size.

C. Flexible Connection: Corrugated bronze hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for system working pressure.

D. Solenoid Valve:
1. Valve: ARI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly with flared, solder, or threaded ends; for system working pressure. Stem shall permit manual operation in case of coil failure.
2. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box 24 volt, confirm and coordinate with DDC controls.

2.4 REFRIGERANT AND LUBRICATING OIL: The Contractor furnish and install all of the refrigerant required to develop the system to its full rating, and in addition to the initial charge, he shall be required to provide, without cost to the Owner, all required refrigerant for the proper operation of the refrigeration apparatus during the first year's operation. The contractor shall be required to provide the initial charge of lubricating oil for all refrigeration apparatus and related equipment. Loss of refrigerant and oil during the first year of operation shall be made good at the contractor's expense.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Use best practices of the trade in all installation. Installation shall conform with the American Standard Code for Pressure Piping, ASA B31.5-1962, Refrigeration Piping. Installed piping shall not interfere with the operation and accessibility of doors or windows; shall not encroach on aisles, passageways, and equipment; and shall not interfere with the servicing or maintenance of equipment. Pipe shall be cut accurately to measurements established at the construction site and shall be worked into place without springing or forcing, properly clearing all openings and equipment. Cutting or weakening of structural members to facilitate piping installation is not permitted. Pipes shall have burrs removed by reaming and shall be so installed as to permit free expansion and contraction without damage to joints or hangers. Piping shall be installed in a straight manner, free from traps, and shall be provided with capped or plugged ends, as it is erected, to prevent dirt from entering the system. The piping system shall be provided with isolating hangers as required to prevent vibration of the compressor operation being carried to the building structure. The piping system shall be provided with gauges as required for the operation of the system, and the suction connection from each coil shall be provided with a test thermometer wall in the pipe for adjustment of the thermostatic expansion valves.

B. Slope of Refrigerant Lines: Slope suction lines down toward compressor 1" per 10 feet. For furnace condensing units only, locate oil traps every 10 feet at all vertical rises against flow in suction lines. Suction line traps shall be standard one-piece traps. Do not install oil traps on split AC systems (SAC, VAC) unless recommended by the manufacturer.

C. Cleanliness: All refrigerant lines and fittings shall be absolutely clean to avoid system operating difficulties and contamination. Use a good cleaning agent such as trichlorethylene.

D. Joints:
1. Brazed joints: Tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned with steel wool, wire brush, or fine emery cloth before sweating.
2. An inert gas (such as oil pumped dry nitrogen) shall be continuously passed through the copper piping when brazing joints to prevent formation of copper oxide. Care shall be taken to prevent annealing of fittings and tubing when making connections. Joints shall be made with silver bearing brazing material.

3.2 TESTING OF REFRIGERATION PIPING SYSTEM: After the installation of the refrigeration piping system has been completed and before insulation is applied, all pipes shall be tested and proven tight for a period of 24 hours at a pressure of 300 pounds per square inch using oil pumped dry nitrogen.

3.3 EVACUATION AND CHARGING: After completion of the piping pressure test, the refrigeration systems shall be evacuated and dehydrated using a vacuum pump capable of producing at least 1 mm Hg absolute. The following procedure shall be followed unless otherwise noted:

A. Connect an accurate high vacuum gauge, such as Stokes or Zimmeril gauge to the system.

B. Connect the vacuum pump to both the high and low side of the system. Leave the compressor suction and discharge service valves closed. Start the vacuum pump.

C. Keep ambient air temperatures above 60^{o} during the evacuation process.

D. Operate the vacuum pump until the system is evacuated to 2.5 mg Hg absolute.

E. Break the system vacuum with oil pumped dry nitrogen. Open the compressor suction and discharge service valves and re-evacuate the system to 2.5 mm Hg absolute.

F. After the system has been double evacuated to 2.5 mm Hg absolute, close the vacuum pump suction valve and stop the pump. Allow the system to stand under a vacuum a minimum of 12 hours. If no noticeable rise in pressure has taken place after 12 hours, the system may be charged. This test shall be made in the presence of the Owner's representative.

END OF SECTION

SECTION 23 31 00
DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 Basic Mechanical Materials and Methods Sections apply to work of this section.

1.2 SUMMARY:

A. Extent of metal ductwork is indicated on drawings and in schedules, and by requirements of this section.

B. Types of ductwork required for the project include the following:
1. Round
2. Rectangular
3. Oval
4. Spiral
5. Factory

C. Exterior Insulation of metal ductwork is specified in other Division-23 07 00 sections and is included as work of this section.

D. Refer to other Division-23 07 00 sections for exterior insulation of metal ductwork; not work of this section.

E. Refer to other Division-23 30 00 sections for ductwork accessories; not work of this section.

F. Refer to other Division-23 sections for fans and air handling units; not work of this section.

G. Refer to other Division-23 09 00 sections for mechanical controls; not work of this section.

H. Refer to other Division-23 37 13 sections for louvers; not work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of metal ductwork products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects with metal ductwork systems work similar to that required for project.

1. The installer shall have a publicly registered bonding capacity of sufficient

amount to cover this work and all other work in progress by the Contractor.

2. All workmen on the project shall carry state licenses as journeymen or apprentice sheet metal workers with additional certification for welders.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data and installation instructions for metal ductwork materials and products.

B. Shop Drawings: Submit scaled layout drawings of metal ductwork and fittings including, but not limited to, duct sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and space relationship between ductwork and proximate equipment. Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced.

C. Record Drawings: At project closeout, submit record drawings of installed metal ductwork and ductwork products, in accordance with requirements of General Conditions.

D. Maintenance Data: Submit maintenance data and parts lists for metal ductwork materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual; in accordance with requirements of General Conditions.

1.5 REFERENCES:

A. Codes and Standards:

1. SMACNA Standards: Comply with SMACNA "HVAC Duct Construction Standards, Metal and Flexible" for fabrication and installation of metal ductwork.
2. ASHRAE Standards: Comply with ASHRAE Handbook, Equipment Volume, Chapter 1 "Duct Construction", for fabrication and installation of metal ductwork.
3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air-Conditioning and Ventilating Systems" and NFPA 90B "Standard for the Installation of Warm Air Heating and Air-Conditioning Systems".
4. International Building Code/International Mechanical Code: Comply with all sections pertaining to mechanical work.

B. Field Reference Manual: Have available for reference at project field office, copy of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Protection: Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Storage: Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclosed with waterproof wrapping.

PART 2 - PRODUCTS

2.1 DUCTWORK - GENERAL:

A. Standards: All duct fabrications shall comply with standards and techniques detailed by SMACNA "Duct Construction Manuals" for the appropriate pressure class, and with the ASHRAE Handbook, 1988 edition, Chapter 1, Duct Construction

B. Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lock forming quality, with G 90 zinc coating in accordance with ASTM A 525; mill phosphatized for exposed locations.

C. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting. Installation of exposed ductwork shall be laid out in advance and submitted for review. Ductwork shall be hung straight and uniform, points shall be true, and seams shall show continuity.

D. Stainless Steel Materials: Fabricate of Type 304 SS or Type 316 SS stainless steel sheet complying with ASTM A-167 with all welded joints and seams. Provide polished No. 4 satin finish for all hoods and duct exposed to view, No. 1 finish elsewhere. Protect finished surfaces with mill applied adhesive protective paper through fabrication and installation.

2.2 FITTINGS AND FABRICATION:

A. Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15^{o} change of direction per section. Unless specifically detailed otherwise, use 45^{o} lateral and 45^{o} elbows for branch take-off connections. Where 90^{o} branches are indicated, provide conical type tees.

B. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to associated duct width; and fabricate to include turning vanes in elbows where shorter radius is necessary. Limit angular tapers to 30^{o} for contracting tapers and 20^{o} for expanding tapers.

C. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division-23 section "Duct Accessories' for accessory requirements.

D. Fabricate ductwork with duct liner in each section of duct where indicated. Laminate liner to internal surfaces of duct in accordance with instructions by manufacturers of lining and adhesive, and fasten with mechanical fasteners.

E. Offset, transition, and adapt ductwork to structural obstacles and work of other trades in a coordinated effort. Layout work to avoid conflict with piping, etc. With review of conditions, teardrop around conflicting piping, lights, etc., all at no added cost to the owner.

2.3 DUCT PRESSURE CLASSIFICATIONS:

A. For all VAV systems, which include but are not limited to

1. From fan discharge to air terminal unit: medium pressure ductwork, 10" w.g.
2. Rectangular supply air ductwork from air terminal unit, rectangular and round ductwork: Low pressure rectangular ductwork, 3" w.g.

3. All low pressure round supply air ductwork exposed to view; spiral lock seam, 3" w.g.
4. Branch round supply air ductwork runout from rectangular ductwork to diffuser: Low pressure round ductwork, 1" w.g.
5. Outside air ductwork and plenums, 10" w.g.
6. Relief air plenums, 3" w.g.

B. Low pressure exhaust ductwork and ventilation systems, which include but are not necessarily limited to exhaust fan systems and ventilation systems.
1. Low pressure rectangular ductwork, 3" w.g. Increase metal gauge by 2 (i.e., 20 to 18) for all sizes.

2.4 LOW PRESSURE ROUND DUCTWORK: (1" SMACNA Pressure Class)

A. Round type ductwork for use on low velocity supply systems (1200 fpm maximum), low pressure (0.75" maximum duct pressure), shall be fabricated on 26 gauge galvanized steel sheets with snap-lock longitudinal seams and crimped and beaded joins.

B. All end joints shall have at least three screw fasteners and shall be wrapped airtight. Transverse and longitudinal seams shall be sealed with duct cement. Elbows and fittings shall provide smooth air flow patterns and have a neat appearance.

C. Use factory fabricated elbows of the multi-sectional adjustable type.

2.5 LOW PRESSURE RECTANGULAR DUCTWORK: (3" SMACNA Pressure Class)

A. Rectangular ductwork for use on supply systems up to 2" maximum duct static pressure and 2000 fpm maximum duct velocity shall be constructed of galvanized steel using construction for nominal 3" SMACNA rated systems. Seal all transverse joints with duct cement.

B. Use radius elbows or turning vanes with extended trailing edge. Use a true 1-1/2 time 45° tapping takeoffs with downstream balance damper.

C. Duct dimensions are inside clear. Increase for acoustical lining.
D. For rectangular exhaust ducts, increase metal gauge by 2 (i.e. 20 to 18) for all sizes. Seal all joints.

2.6 MEDIUM PRESSURE DUCTWORK: (10" SMACNA Pressure Class)

A. General: At Installer's option, provide factory-fabricated duct and fittings, in lieu of shop-fabricated duct and fittings.

B. Round Ductwork: Construct of galvanized sheet steel complying with ASTM A 527 by the following methods and in minimum gauges listed.

Diameter	Minimum Gauge	Method of Manufacture
3" to 14"	26	Spiral Lockseam

15" to 26"	24	Spiral Lockseam
27" to 36"	22	Spiral Lockseam
37" to 50"	20	Spiral Lockseam
51" to 60"	18	Spiral Lockseam
Over 60"	16	Longitudinal Seam
60" to 84"	18	Spiral Lockseam

Provide locked seams for spiral duct; fusion-welded butt seam for longitudinal seam duct.

C. Round Duct Fittings and Couplings: Construct of minimum gauges listed. Provide continuous welds along seams. Mitered elbows shall be of at least 5 piece construction with R/D ratio of 1.5. All branch takeoffs shall be a true 45º takeoff having an overall throat width at the main duct connection of 1-1/2 times the sizes of the branch duct.

Diameter	Minimum Gauge
3" to 36"	20
38" to 50"	18
Over 50"	16

D. Flat-Oval Ductwork: Construct of galvanized sheet steel complying with ASTM A 527, of spiral lockseam or longitudinal seam construction, in minimum gauges listed.

Maximum Width	Minimum Gauge Spiral	Longitudinal
Under 25"	24	22
25" to 48"	22	20
49" to 70"	20	18 Stiffener Inserts 4'-0" on Center

E. Flat-Oval Duct Fittings and Couplings: Construct of minimum gauges listed. Provide continuous weld along seams.

Maximum Width	Minimum Gauge
Under 37"	20
37" to 50"	18
Over 50"	16

F. Double wall Internally Insulated Duct and Fittings: Construct with outer pressure shell, 1" or 2" thick (as indicated on drawings) insulation layer, and perforated inner liner. Construct shell and liner of galvanized sheet steel complying with ASTM A 527, of spiral lockseam construction, use longitudinal seam for over 59", in minimum gauges listed. Use where indicated on drawings.

Equivalent to United McGill "Acoustic-K27".

Nominal Duct Diameter	Outer Shell	Inner Liner
3" to 12"	26 gauge	24 gauge
13" to 24"	24 gauge	24 gauge
25" to 34"	22 gauge	24 gauge
35" to 48"	20 gauge	24 gauge
49" to 58"	18 gauge	24 gauge
Over 59"	16 gauge	20 gauge

G. Fittings and Couplings: Construct of minimum gauges listed. Provide continuous weld along seams of outer shell. Construct fittings to close tolerance with ductwork.

Nominal Duct Diameter	Outer Shell	Inner Liner
3" to 34"	20 gauge	20 gauge
36" to 48"	18 gauge	20 gauge
Over 48"	16 gauge	20 gauge

H. Field joints shall be sealed using duct cement. Duct sections and fittings shall be held in place at joints with sheet metal screws 6" on centers. Simple coating of joint surfaces with mastic prior to joining is not acceptable (SMACNA Std. P.1-11).

I. Oval ductwork shall be installed where called for on the plans and where required to conform to tight space requirements encountered during construction. The contractor shall furnish transition pieces as required. Oval ductwork shall have equivalent capacity to the round duct.

At the Contractor's option odd inch diameter round ducts may be increased in size to the next larger even inch providing space considerations are accommodated and all related conditions are resolved by the contractor.

2.7 FACTORY DUCT:

A. Extent of Work: Provide factory duct at connections to air terminal units, at runouts to grilles and diffusers, at points of round to round flexible connections (see also "Flexible Connections") and at other locations indicated or required.

B. Prohibited Material: Do not use single wire helix ducting with vinyl or plastic liner of any type.

C. Factory Duct Non-corrosive Environments: Woven fiberglass fabric impregnated with vinyl or neoprene clamped in a continual helix of aluminum or cold rolled steel. U.L. listed for Class 1 duct, compliant with NFPA 90A and 90B, pressure rated to 12" w.g., equivalent to:

D. Non-insulated: Wiremold 57; Flexmaster Type N145

E. Insulated: Flexmaster Type 4; Thermaflex M-KC

F. Installation: Follow manufacturers instructions. Use stainless steel or nylon band clamping rings. In general, do not use lengths in excess of 3 feet. Make bends only in

long radius format. Support duct to avoid droops and kinks.

2.8 MISCELLANEOUS DUCTWORK MATERIALS:

A. General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.

B. Runout Fittings: Runout fittings shall be used to make round to rectangular duct connections. Use 45° time and a half square to round fittings. Provide with locking quadrant dampers where balance is involved. Provide with insulation guard where insulated duct is involved. Manufacturer: Hercules.

C. Duct Sealing Compound: Duct sealing compound shall be 3M brand number EC-750 or Duro-Dyne S-2. This material shall be used in making up duct joints or in water proofing, caulking plenums, etc.

D. Acoustical Lining: Acoustical lining in ducts shall be 1" thick, 1-1/2 pound density, coated, flexible glass fiber type, set in adhesive and impaled on weld studs spaced not more than 12" on centers and secured with lock washers. Airstream surface faced with black coated matte. Acoustical lining shall completely line the ducts. Lining shall have a fire and smoke hazard rating not exceeding 20-50-50. Owens-Corning, Johns-Manville, Certainteed.
   1. All joints, edges and/or surface breaks in the coating of the acoustical lining shall be pointed up to a smooth surface with adhesive.

E. Duct Liner Adhesive: Comply with ASTM C 916 "Specifications for Adhesives and Duct Thermal Insulation".

F. Duct Liner Fasteners: Comply with SMACNA HVAC Duct Construction Standards, Article S2.11.

G. Duct Cement: Non-hardening migrating mastic or liquid neoprene based cement (type applicable for fabrication/ installation detail) as compounded and recommended by manufacturer specifically for cementing fitting components, or longitudinal seams in ductwork. DP1010, or Polymetrics

H. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.

PART 3 - EXECUTION

3.1 INSPECTION:

A. General: Examine areas and conditions under which metal ductwork is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF METAL DUCTWORK:

A. General: Assemble and install ductwork in accordance with recognized industry

practices which will achieve air tight (5% leakage for systems rated 3" and under; 1% for systems rated over 3") and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor.

All necessary allowance and provisions shall be made in the installation of sheet metal ducts for the structural conditions of the building, and ducts shall be transformed or divided as may be required. Whenever this is necessary, the required area shall be maintained. All of these changes, however, must be approved and installed as directed at project. During the installation, the open ends of ducts shall be protected to prevent debris and dirt from entering.

B. Field Fabrication: Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.

C. Routing: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

D. Electrical Equipment Spaces: Do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures. Maintain clearances above of and in front of electrical panels.

E. Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2". Fasten to duct and substrate.
   1. Where ducts pass through fire-rated floors, walls, or partitions, provide firestopping between duct and substrate, in accordance with requirements of Section "Firestopping".

F. Ducts At Structural and Architectural Penetrations: Where ducts are shown connecting to or passing through concrete, gypsum board, masonry openings and along edges of all plenums at floors and walls, provide a continuous 2" x 2-1/8" galvanized angle iron which shall be bolted to the construction and made airtight to the same by applying caulking compound. Sheet metal in these locations shall be bolted to the angle iron. Round high velocity ducts in vertical chases shall be supported with rolled angle rings. Close openings between duct and structure.

G. Cross Breaking: Rectangular sheet metal ducts shall be cross broken on the four sides of each 4-foot panel. All vertical and horizontal sheet metal barriers, duct offsets, elbows, as well as 4-foot panels of straight sections of ducts shall be cross broken.

Cross breaking shall be applied to the sheet metal between the standing seams or reinforcing angles; the center of cross break shall be of the required height to assure surfaces being rigid.

H. Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.

I. Installation: Install metal ductwork in accordance with SMACNA HVAC Duct Construction Standards.
1. Related to final installation cleanliness, damp wipe all ductwork on installation. Cap open duct ends, cover fan inlets, vacuum fan plenums and related installation before starting fans. Run fans only with filters in place.

3.3 INSTALLATION OF DUCT LINER:

A. General: Install duct liner in accordance with SMACNA HVAC Duct Construction Standards.

As indicated on the drawings, supply, return and exhaust air ductwork shall be lined with acoustical insulation.

In all cases outside air ductwork shall be lined with 2" thick 1-1/2 lb. density acoustical lining unless indicated differently on drawings, i.e. requiring Type 2 plenum.

3.4 INSTALLATION OF FLEXIBLE DUCTS:

A. Maximum Length: For any duct run using flexible ductwork, do not exceed 3'-0" extended length. No elbows allowed.

B. Installation: Install in accordance with Section III of SMACNA's "HVAC Duct Construction Standards, Metal and Flexible".

3.5 HANGERS AND SUPPORTS:

A. It is essential that all ducts shall be rigidly supported. Hangers for low velocity ducts up to 18" in width shall be placed on not more than 10' centers.

Low velocity ducts 19" through 35" in width and greater shall be supported on not more than 5' centers. Where vertical ducts pass through floors or roofs, heavy supporting angles shall be attached to ducts, and to structure. Angles shall be of sufficient size to support the ductwork rigidly and shall be placed on at least two sides of the duct.

B. Construct hangers for rectangular ductwork from galvanized iron l" x 1/16". Hangers shall extend down the sides of rectangular ducts the full depth of the duct and shall be bent underneath the duct 2". Hangers shall be secured to the duct using sheet metal screws or rivets of appropriate sizes on 6" centers, but not less than two screws in the side and one in the bottom of each hanger.

C. For rectangular ducts 36" and greater in width construct hangers from galvanized iron 1-1/2" x 1/16". Hangers shall be installed and secured to duct as described in Paragraph B.

3.6 SUPPORTING DAMPERS: Parallel and opposed blade motor operated dampers shall be supported by reinforcing the ductwork or sheet metal walls at the damper locations to carry

the weight of the dampers and the force exerted on the dampers due to air pressure, or shall be supported independent of ductwork from the ceiling or floor, as conditions at the site determine.

3.7 CONNECTIONS: Connections of high velocity supply and exhaust ducts, fittings, and high velocity mixing boxes shall be made airtight by coating joints with Minnesota Mining Co. Mastic, Type EC-800, Benjamin Foster, Sheet Metal Products Co., or approved equal, before joining, and then sealing the joint with one layer of "Glass-Fab" reinforcing tape set in a coating of the above compound. Tape and sealant shall not exceed a flame spread of 25 or a smoke development of 50.

3.8 WELDED JOINTS: Welded ductwork shall have either an angle or a piece of 1/8" steel bar behind each weld to allow laying of a neat and continuous bead.

3.9 AESTHETIC LAYOUTS: Contractor shall locate all diffusers, grilles and other exposed items in such a manner as to fit symmetrically in any grid system or other aesthetic architectural or lighting pattern. Refer to reflected ceiling plans and electrical lighting layouts for additional information. Provide duct offsets or extensions as required to make a proper installation.

A. Close or cap all duct ends. Use auxiliary blower with air flow meter to establish a duct pressure equivalent to the duct pressure class. Inspect all joints in duct system and seal all identifiable leaks.

B. In areas with exposed ductwork, contractor shall limit the number of duct connections to as few as possible. Where possible provide duct down stream of VAVR boxes as one continuous spiral round or oval (as indicated on drawing) duct. Exposed ductwork joints shall be made with the Ductmate, Spiralmate connection system or equal by approved manufacturer. Connections shall be clean with the ring tightening bolt on the top of the duct and the excess bolt length cut off. Joint locations shall be uniform, ie. in adjacent parallel duct runs the joints shall be in the same location for each duct run.

3.10 FIELD QUALITY CONTROL:

A. Leakage Tests: After each duct system which is constructed for duct classes over 3" is completed, test for duct leakage in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Air leaks which are in excess of that required to bubble the soap suds (that is, actually blow the suds away) shall be sealed by additional taping and caulking to reduce the leakage to a rate not to exceed slow bubbles forming. Repair leaks and repeat tests until total leakage conforms with Chart of Figure 4-1, Seal Class A, and Leakage Class 3 for round/oval, 6 for rectangular.

3.11 EQUIPMENT CONNECTION:

A. General: Connect metal ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors as indicated.

3.12 ADJUSTING AND CLEANING:

A. Clean ductwork internally of dust and debris, as follows: Before the ceilings are installed, with filters in place, operate the fans at full capacity to blow out dirt and debris from ducts. If it is not practical to use the main supply blower for this test, the ducts may be blown out in sections by a portable fan.

B. Clean external surfaces of foreign substances which might cause corrosive

deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

C. Balancing:
   1. Refer to Division-23 section "Testing, Adjusting, and Balancing" for air distribution balancing of metal ductwork; not work of this section. However, the Sheet Metal Contractor shall participate fully in this work. Seal any leaks in ductwork that become apparent in balancing process.
   2. If specified conditions cannot be obtained due to deficiencies in equipment performance or improper installation or workmanship, the Mechanical Contractor and his subcontractors shall make any changes necessary to obtain the specified conditions.

END OF SECTION

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SECTION 23 33 00
DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 Basic Mechanical Materials and Methods sections apply to work of this section.

1.2 SUMMARY:

A. Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this section.

B. Types of ductwork accessories required for project include the following:
   1. Dampers.
      a. Low pressure manual dampers.
      b. Control dampers.
   2. Turning vanes.
   3. Duct hardware.
   4. Duct access doors.
   5. Flexible connections.

C. Refer to other Division-23 sections for testing, adjusting, and balancing of ductwork accessories; not work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of ductwork accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction; and installation instructions.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components.

C. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of General Conditions.

1.5 REFERENCES:

A. Codes and Standards:

1. SMACNA Compliance: Comply with applicable portions of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".
2. Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.
3. UL Compliance: Construct, test, and label fire dampers in accordance with UL Standard 555 "Fire Dampers and Ceiling Dampers".
4. NFPA Compliance: Comply with applicable provisions of NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Protection: Protect shop-fabricated and factory-fabricated accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Storage: Where possible, store accessories inside and protect from weather. Where necessary to store outside, store above grade and enclosed with waterproof wrapping.

PART 2 - PRODUCTS

2.1 DAMPERS:

A. Control dampers are furnished by this Section and installed by this Section. Dampers shall be supported, plenum openings shall be reinforced, the entire assembly shall be sturdy and operate smoothly. Install dampers to direct outside and return air into each other for mixing. Control dampers for relief air, return air, ventilation air, exhaust air, outside air, and supply air. Low leakage type with spring loaded side seals, inflatable butyl or neoprene fabric edge seals, bronze or teflon bearings, reinforced extruded aluminum airfoil blades, aluminum frame. Action as indicated on drawings. Air leakage not to exceed 5 CFM per square foot at 4" upstream static pressure.
1. Ruskin CD-50
2. Greenheck VCD-43
3. Tamco 1000

B. Control dampers for balance only where tight shutoff is not critical are to be furnished and installed by this Section. 6" galvanized blade, poly foam blade seals, flexible metal jamb. Parallel blade operation.
1. Ruskin CD-35
2. Greenheck
3. Tamco

2.2 TURNING VANES: Turning vanes shall be installed in all square elbows. Turning vanes shall be single blade with trailing edge. Turning vane spacing shall be per SMACNA. Each blade shall be tack welded or crimped to the carrier frame to prevent rattling.

2.3 DUCT HARDWARE:

A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:
1. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, cover, for instrument tests. Ventlok No. 699 closures shall be provided and installed for each test hole, with sufficient neck length to penetrate the insulation.

2. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork. (Bare duct - Ventlok 620, 635; Insulated duct - Ventlok 627, 628, 637, 638, 629.)

B. Manufacturer: Subject to compliance with requirements, provide duct hardware of one of the following:
   1. Ventfabrics, Inc.
   2. Young Regulator Co.

C. Concealed Ceiling Damper Regulator: Provide remote damper adjusters for all hand balancing dampers above inaccessible ceilings. Run cable to accessible location above the ceiling and secure the end connection. Note the location of cables and point of adjustment on a set of drawings to be included in the O&M manual. Contractor has the option to use and engineer approved electric type remote balance damper system.
   1. Approved Manufacturers and Models:
      a. Young-Bowden Cable System.

2.4 DUCT ACCESS DOORS:

A. Doors shall be 2" narrower than the duct width by 24" up to a maximum of 24" x 24". Duct access doors shall be furnished for all fire damper links, manual controllers and adjustable balancing devices.

B. Small Access Doors - Low Pressure Ductwork Only (4 sq. ft. and smaller)
   1. Reach-In Doors -
   2. Factory built, insulated, 24 gage minimum galvanized sheet metal access door with hinges and sash locks.
   3. Wall Construction -
      a. Single wall in un-insulated ducts.
      b. Double wall with one inch thick insulation between for insulated ducts.
      c. Provide steel angle frame for access doors.
   4. Approved Manufacturers And Models -
      a. Air Balance Inc - FSA100
      b. Cesco-Advanced Air - HAD-10
      c. Kees Inc - ADH-D
      d. Pottorff - HAD60
      e. Ruskin - ADH22

C. Access Doors - All Medium Pressure Ductwork

   1. Bolted access door, oval shaped, constructed of an outer door connected to an inner plate by spring loaded carriage bolts with wing handles, inner plate to have cellular sponge gasket for leak free operation up to 20" wg. The door shall have permanently bonded polyester insulation.
      a. 10" L x 6" H for 8" - 16" Diameter
      b. 16" L x 12" H for 16" - 46" Diameter

2.5 WALL AND CEILING ACCESS DOORS: Wall and ceiling doors at fire dampers and smoke dampers shall be the same as specified in Section 230000. Doors shall be sized for easy access to fire links and not less than 24" x 24" where possible.

2.6 FLEXIBLE CONNECTIONS:

A. Extent of Work: Provide flexible connections between ductwork or plenums and equipment, such as at fan inlets and discharges, and at other places indicated on the drawings or called for by note or specification.

B. Non-Corrosive Environment or Airstream: Provide material of heavy waterproof woven glass fabric double coated with neoprene or hypalon equivalent to "Ventglas" for interior locations and "Ventlon" for exterior locations, fabric not less than 3-1/4" wide clamped between strips of 24 gauge galvanized iron. Material by Ventfabrics, Inc., Chicago, Ill.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF DUCTWORK ACCESSORIES:

A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Install hand operated volume dampers at locations and of sizes shown. Volume dampers shall be controlled by heavy duty locking quadrants mounted on the outside of the duct. Where ducts are insulated, the damper rod shall be extended and the operator shall be mounted on the outside of the insulation. Butterfly dampers may be constructed by the Sheet Metal Contractor. All multi-blade hand dampers shall be the product of one of the manufacturers listed in the Contract Documents. All operator fittings shall be heavy duty commercial grade.

C. Install turning vanes in square or rectangular 90 degree elbows in supply and exhaust air systems, and elsewhere as indicated.

D. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

E. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.3 FIELD QUALITY CONTROL:

A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak proof performance.

3.4 ADJUSTING AND CLEANING:

A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.

1. Label access doors in accordance with Division-23 section "Mechanical Identification".
2. Final positioning of manual dampers is specified in Division- 23 section "Testing, Adjusting, and Balancing".
3. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.5 EXTRA STOCK:

A. Furnish extra fusible links to Owner, one link for every 10 installed of each temperature range; obtain receipt.

END OF SECTION

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SECTION 23 34 00
VENTILATION AND EXHAUST FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To
   1. Furnish and install exhaust fan units as described in Contract Documents.

B. Types of exhaust fans specified in this section include the following:
   1. Rooftop Exhaust Fan
   2. Rooftop Relief Air Fan
   3. Ceiling Exhaust Fan

C. Related Sections
   1. Section 23 00 00 - General Mechanical Requirements
   2. Section 23 05 13 – Motors

D. Submittals
   1. Product Data: Submit manufacturer's technical data for power ventilators, including specifications, capacity ratings, dimensions, weights, materials, accessories furnished, and installation instructions.
   2. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, construction details, methods of assembly of components, and field connection details.
   3. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to power ventilators. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
   4. Maintenance Data: Submit maintenance data and parts list for each type of power ventilator, accessory, and control. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 23.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Roof Mounted Exhaust/Relief Fans:

   1. Fan shall be a spun aluminum, roof mounted, direct driven, downblast (or upblast) centrifugal exhaust ventilator.
   2. Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.
   3. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a

rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The discharge baffle shall have a rolled bead for added strength. An integral conduit chase shall be provided through the curb cap and into the motor compartment to facilitate wiring connections. The motor shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM and static pressure.

4. Fan wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub. An aerodynamic aluminum inlet cone shall be provided for maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-05, *Balance Quality and Vibration Levels for Fans.*
5. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase. Where required by mechanical schedule, motor shall be an electronically commutated motor rated for continuous duty and furnished with internally mounted potentiometer speed controller.
6. Furnish with factory installed and wired isolation damper complete with electric damper actuator. Damper shall be Ruskin CD50 or Greenheck VCD43. Damper shall be mounted inside the curb and accessed thru the hinged opening between the curb and fan base.
7. Manufacturer: Subject to compliance with requirements, provide exhaust fans on one of the following:
   a. Cook
   b. Acme
   c. Greenheck
   d. Twin City

B. Ceiling Exhaust Fan (CEF):
1. Ceiling mounted fans shall have acoustically insulated housings and shall have a maximum sound level rating of 3.1 sones. Fans shall bear the AMCA seal and the UL label. Integral backdraft damper shall be totally chatterproof with no metal to metal contact. Fans shall have true centrifugal wheels. Entire fan, motor and wheel assembly shall be easily removable without disturbing the housing. Furnish unit with appropriate ceiling grille having a minimum 85% free open area. Motor speed shall not exceed 1050 rpm. All motors shall be suitably grounded and mounted on rubber in shear vibration isolators. Hang fan from structure on metal bands. The fan shall turn on as noted.
2. Manufacturer:
   a. Cook.
   b. Acme.
   c. Greenheck
   d. Twin City

PART 3 - EXECUTION

3.1 INSTALLATION

A. Securely support inline exhaust and ventilation fans with seismic spring isolators suspended from structure or supported from floor.

3.2 INSPECTION:

A. General: Examine areas and conditions under which power ventilators are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.3 INSTALLATION OF POWER EXHAUST FANS AND VENTILATORS:

A. General: Except as otherwise indicated or specified, install power ventilators in accordance with manufacturer's installation instructions and recognized industry practices to ensure that products serve the intended function.

B. Coordinate ventilator work with work of walls, roof and ceilings, as necessary for proper interfacing.

C. Ductwork: Refer to Division 23 section "Ductwork." Connect ducts to ventilators in accordance with manufacturer's installation instructions.

D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted.

E. Remove shipping bolts and temporary supports within ventilators. Adjust dampers for free operation.

F. Hang from or install on spring type vibration isolators, complete with appropriate mounting frame.

3.4 FIELD QUALITY CONTROL:

A. Testing: After installation of ventilators has been completed, test each ventilator to demonstrate proper operation of unit at performance requirements specified. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

3.5 ADJUSTING AND CLEANING:

A. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

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SECTION 23 37 13
AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 SUMMARY:

A. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this section.

B. Types of outlets and inlets required for project include the following:
1. Ceiling/sidewall air grilles/diffusers.
2. Louvers

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects with metal ductwork systems work similar to that required for project.

The Installer shall have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the Contractor.

All workmen on the project shall carry state licenses as journeymen or apprentice sheet metal workers with additional certification for welders.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:
1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings. Indicate selections on data.

B. Samples: 3 samples of each type of finish furnished.

C. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.

D. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

1.5 REFERENCES:

A. Codes and Standards:
1. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".
2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".
3. AMCA Compliance: Test and rate louvers in accordance with AMCA 500 "Test Method for Louvers, Dampers and Shutters".
4. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.
5. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

B. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 GRILLES AND DIFFUSERS:

A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air

diffuser.

D. Adjust all grilles and diffusers to fit neatly in the room ceiling pattern. Set final locations per architectural reflected ceiling plans.

E. Sound Level: The diffuser or grille generated noise shall not exceed a NC30 sound power level curve at a point five feet away form the diffuser or grille.

F. Manufacturers: Subject to compliance with requirements, provide standard grilles and diffusers of one of the following:
1. Hart & Cooley
2. Krueger
3. J and J
4. Carnes
5. Titus
6. EH Price
7. Tuttle & Bailey
8. Anemostat/Waterloo
9. Environmental Air Products
10. Nailor

G. Types: Provide grilles and diffusers of type, capacity, and with accessories and finishes as listed on grille and diffuser schedule and as specified herein.

H. Grilles and Diffusers:
1. Lay-in Ceiling Supply Diffuser (S-1): Krueger Series 1400, square face, round neck, four-way deflection, anti-smudge design, removable inner core, all steel construction, appropriate mounting frame, white baked enamel finish, size as indicated on drawings.
2. Ceiling Supply Diffuser (S-2): Krueger Series SH with adjustable tabs for directional air flow control, square face, round neck, four-way deflection, anti-smudge design, removable inner core, all steel construction, appropriate mounting frame, white baked enamel finish, sponge rubber gasket, size as indicated on drawings.
3. Thermafuser (S-3): Acutherm Model TF-HC, stand-alone VAV diffuser with four blade dampers, individually adjustable cooling and heating setpoints. 24”24” face panel to fit lay-in ceiling, color selected by architect.
4. Sidewall Double Deflection (S-4, S-5): Krueger Series 6880-15, steel construction with adjustable extruded aluminum blades, 1-1/4” blade spacing, white baked-on enamel, size as indicated on drawings.
5. Perforated Return Grille (R-1, 2): Krueger Series 6490. Perforated face, concealed hinge frame, sponge rubber gasket, white baked-on enamel, size as indicated on drawings.
6. Ceiling Exhaust Grille (E-1, 2): Krueger Series AFCS585, aluminum construction, single deflection exhaust grille with ½” blade spacing. Size as indicated on drawings, color selected by architect.
7. Sidewall Industrial Transfer Grille (T-1): Krueger Series S480H. Heavy duty steel construction, appropriate mounted frame, 1/2” blade spacing, blades on 38 deg. angle unless otherwise shown on drawings, sponge rubber gasket, size

as indicated on drawings. Color selected by Architects.

2.2 LOUVERS:

A. Extent of Work: At air openings in the outside wall where indicated on drawings, install AMCA rated drainable stationary extruded aluminum 6" deep weather louvers.

B. Material: Blades shall be on 3-1/2" centers with integral downspouts to drain the water from the louver blades. Stationary louvers shall pass 1000 fpm free area velocity with less than 0.2" static pressure drop and shall carry less than .03 ounces of water per square foot when tested in accordance with AMCA Standard 500. Install stainless steel 1/2" mesh screens on interior face and louver.
1. Louvers shall be equal to Ruskin ELF6375DX American Warming and Ventilating LE-31, Louvers and Dampers, Krueger, Ruskin, Greeheck, Pottorff. Coordinate with the Architectural details for type of flange and structural details for actual wall opening sizes. Anodized aluminum finish.

C. Contractor must coordinate louver size, flange type, and construction with structural and architectural openings to assure fit and appearance. Louvers shall be one piece.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to ensure that products serve intended function.

B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.

C. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling module.

END OF SECTION

SECTION 23 42 00
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division 23, "Basic Mechanical Materials and Methods" sections apply to work of this section.

1.2 SUMMARY:

A. This Section specifies plumbing fixtures and trim. The types of fixtures specified includes the following:
   1. See Plumbing Fixture Schedule

1.3 SUBMITTALS:

A. Product Data: Submit Product Data and installation instructions for each fixture, faucet, specialties, accessories, and trim specified; clearly indicate rated capacities of selected models of water coolers.

B. Shop Drawings: Submit rough-in drawings. Detail dimensions, rough-in requirements, required clearances, and methods of assembly of components and anchorages. Coordinate requirements with fixtures installed in countertops and cabinets. Furnish templates.

C. Color Charts: Submit manufacturer's standard color charts for fixture colors.

D. Maintenance Data: Include data in Maintenance Manual specified in Division 1 and Section 220100.

1.4 REFERENCES:

A. Codes and Standards:
   1. ASHRAE Standard 18: "Method of Testing for Rating Drinking Water Coolers with Self-Contained Mechanical Refrigeration Systems".
   2. ARI Standard 1010: "Drinking-Fountains and Self-Contained Mechanically-Refrigerated Drinking-Water Coolers."
   3. ANSI Standards A117.1: "Specifications for Making Buildings and Facilities Accessible To and Usable By Physically Handicapped People."
   4. ADA: Americans with Disability Act.
   5. International Plumbing Code 2018 with Utah State Amendments

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Store fixtures where environmental conditions are uniformly maintained within the manufacturer's recommend temperatures to prevent damage.

B. Store fixtures and Trim in the manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage to the fixture or

trim.

1.6 SEQUENCE AND SCHEDULING:

A. Schedule rough-in installations with the installation of other building components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer uniformity shall be as specified in the general conditions section of the specification.

2.2 FIXTURES AND TRIM: The model numbers listed below have been carefully selected to help bidders in the submittal process of selecting fixtures and trim. The completeness and accuracy of these numbers must be verified during the bidding process. Any discrepancies between the model numbers and the fixture, or trim descriptions noted by a manufacturer during the bidding process will be reported to the Architect / Engineer for clarification. Clarifications will be made a part of the contract through an addendum only. The contractor is responsible for reporting any clarifications before the bid date as required in this specification.

A. See Plumbing Fixture Schedule for fixture specifications and manufacturers.

B. Trim and Accessories:
1. Supplies and Stops:
a. Chrome plated cast brass angle stop, ball type quarter turn valve. Provide with flexible chrome plated copper riser, chrome plated escutcheon, compression type connections.
b. Approved Manufacturers:
(1) Watts “Kwikstop”
(2) Brass Craft KT Series
(3) McGuire
2. P-Trap:
a. 17 gauge, tubular brass, chrome plated and chrome escutcheons.
b. Approved Manufacturers:
(1) Dearborn
(2) McGuire
(3) Jameco
(4) Zurn
(5) ProFlo
3. Lavatory Pre-formed Insulation and Protective Cover:
a. Pre-formed foam or fiberglass insulation with two piece white PVC snap on cover with velcro closure, to fit P-trap and hot and cold water stops and supplies, meet 25/50 flame/smoke rating.
b. Approved Manufacturer:
(1) Truebro
(2) Plumberex
(3) ProFlo
4. Carriers:
a. Electric Water Cooler: Provide floor mounted carrier system with adjustable top and bottom support plates, dura-coated rectangular steel uprights with welded feet and mounting fasteners.
b. Approved Manufacturers:

(1) J. R. Smith
(2) Josam
(3) Wade
(4) Zurn
(5) Mifab

PART 3 - PLUMBING FIXTURES

3.1 EXAMINATION:

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine rough-in for potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures.

C. Examine floors, walls, and cabinets for suitable conditions where fixtures are to be installed.

D. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION:

A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings, and pertinent codes and regulations, the original design, and the referenced standards.

B. Comply with the installation requirements of ANSI A117.1 and Public Law 90-480 with respect to plumbing fixtures for the physically handicapped.

C. Fasten plumbing fixtures securely to supports or building structure. Secure supplies behind or within wall construction to provide rigid installation.

D. Install a stop valve in an accessible location in the water connection to each fixture.

E. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork.

F. Seal fixtures to walls and floors using silicone sealant. Match sealant color to fixture color.

3.3 FIELD QUALITY CONTROL:

A. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, the retest. Also test for rigidity of fixtures hung on carriers, flush valves, etc.

B. Inspect each installed unit for damage. Replace damaged fixtures.

3.4 ADJUSTING:

A. Adjust water pressure at drinking fountains, faucets and flush valves to provide proper flow stream.

B. Replace washers of leaking or dripping faucets and stops.

3.5 CLEANING:

A. Clean fixtures, trim, and strainers using manufacturer's recommended cleaning methods and materials.

3.6 PROTECTION:

A. Provide protective covering for installed fixtures, water coolers, and trim.

B. Do not allow use of fixtures for temporary facilities unless expressly approved in writing by the Company.

END OF SECTION

SECTION 23 74 10
PACKAGED ROOFTOP UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 General Mechanical Requirements, and General Pipes and Fittings sections apply to work of this section.

1.2 SUMMARY:

A. Extent of rooftop unit work is indicated on drawings, schedules, and by requirements of this section.

B. Types of packaged air-handling units specified in this section include the following:
1. Rooftop Unit.

C. Refer to Division-26 sections for the following work.
1. Power supply wiring from power source to power connection on unit. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory installed.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of packaged rooftop units with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects with packaged rooftop units work similar to that required for project.

C. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

D. Energy Efficiency Ratio: Equal to or greater than prescribed by the adopted version of ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for packaged rooftop units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, gages and finishes of materials, and installation instructions.

B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, weight loadings, required clearances, construction details, and field connection details. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to packaged rooftop units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals; in accordance with requirements of Division 23 00 00.

1.5 REFERENCES:

A. Codes and Standards:
1. AMCA Compliance: Test and rate packaged rooftop units in accordance with AMCA standards.
2. ARI Compliance: Test and rate packaged rooftop units in accordance with ARI 430 "Standard for Central-Station Packaged rooftop units", display certification symbol on units of certified models.
3. ASHRAE Compliance: Construct and install refrigerant coils in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".
4. NFPA Compliance: Provide packaged rooftop unit internal insulation having flame spread rating not over 25 and smoke developed rating no higher than 50; and complying with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".
5. NEC Compliance: Comply with National Electrical Code (NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of packaged rooftop units.
6. International Building Code/International Mechanical Code: Comply with all sections pertaining to mechanical work.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver packaged rooftop units with factory-installed shipping skids and lifting lugs; pack components in factory-fabricated protective containers.

B. Handle packaged rooftop units carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to air-handling unit manufacturer.

C. Store packaged rooftop units in clean dry place and protect from weather and construction traffic. Where necessary to store outside, store above grade and enclosed with waterproof wrapping.

D. Comply with Manufacturer's rigging and installation instructions for unloading packaged rooftop units and moving them to final location.

1.7 COORDINATION

A. Coordinate installation of roof curbs and roof penetrations with roof construction.

PART 2 - PRODUCTS

2.1 ROOFTOP UNIT (RTU-1,2):

A. Description: Factory assembled and tested; designed for roof installation; and consisting of compressors, condensers, evaporator coils, condenser and evaporator fans, relief fan, gas heater, filters, dampers and factory installed digital controls.
   1. Approved Manufacturers
      a. Carrier
      b. Aaon
      c. Daikin Applied
      d. Trane
      e. Lennox
      f. BDP
      g. York

B. HVAC Equipment Insulation
   1. Evaporator fan compartment:
      a. Interior cabinet surfaces shall be insulated with a minimum 1/2-in. thick, minimum 1 1/2 lb density, flexible fiberglass insulation bonded with a phenolic binder, neoprene coated on the air side.
      b. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.

   2. Gas heat compartment:
      a. Aluminum foil-faced fiberglass insulation shall be used.
      b. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.

C. Instrumentation and Control Devices for HVAC
   1. DDC Controls: Field installed control by Alerton.

D. Electric and Electronic Control System for HVAC
   1. General:
      a. Shall be complete with self-contained low-voltage control circuit protected by a resettable circuit breaker on the 24-v transformer side.

Transformer shall have 75VA capability.

b. Shall utilize color-coded wiring.

c. Shall include a central control terminal board to conveniently and safely provide connection points for vital control functions such as: smoke detectors, phase monitor, gas controller, economizer, sensors and low and high pressure switches.

d. The heat exchanger shall be controlled by an integrated gas controller (IGC) microprocessor. See heat exchanger section of this specification.

2. Safeties:

a. Compressor over-temperature, over-current. High internal pressure differential.

b. Low-pressure switch.

1) Units with 2 compressors or more shall have different sized connectors for the circuit 1 and circuit 2 low and high pressure switches. They shall physically prevent the cross-wiring of the safety switches between circuits 1 and 2.

2) Low pressure switch shall use different color wire than the high pressure switch. The purpose is to assist the installer and service technician to correctly wire and or troubleshoot the rooftop unit.

c. High-pressure switch.

1) Units with 2 compressors or more shall have different sized connectors for the circuit 1 and circuit 2 low and high pressure switches. They shall physically prevent the cross-wiring of the safety switches between circuits 1 and 2.

2) High pressure switch shall use different color wire than the low pressure switch. The purpose is to assist the installer and service technician to correctly wire and or troubleshoot the rooftop unit.

d. Automatic reset, motor thermal overload protector.

e. Heating section shall be provided with the following minimum protections:

1) High-temperature limit switches.

2) Induced draft motor speed sensor.

3) Flame rollout switch.

4) Flame proving controls.

E. Sequence of Operations for HVAC Controls:

1. Refer to Specification Section 230955, Mechanical Control Systems for unit control sequence.

F. Panel Air Filters:

1. Shall consist of factory-installed, low velocity, disposable 2-in. thick fiberglass filters of commercially available sizes.

2. Unit shall use only one filter size. Multiple sizes are not acceptable.

3. Filters shall be accessible through an access panel with “no-tool” removal as described in the unit cabinet section of this specification.

G. Self-Contained Air Conditioners:

1. General:
   a. Outdoor, rooftop mounted, electrically controlled, heating and cooling unit utilizing a fully hermetic scroll compressor(s) for cooling duty and gas combustion for heating duty.
   b. Factory assembled, single-piece heating and cooling rooftop unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and special features required prior to field start-up.
   c. Unit shall use environmentally sound, PuronR refrigerant.
   d. Unit shall be installed in accordance with the manufacturer's instructions.
   e. Unit must be selected and installed in compliance with local, state, and federal codes.
2. Quality Assurance
   a. Unit meets ASHRAE 90.1 minimum efficiency requirements.
   b. 3 phase units are Energy Star certified.
   c. Unit shall be rated in accordance with AHRI Standards 210/240 and 340/360.
   d. Unit shall be designed to conform to ASHRAE 15, 2001.
   e. Unit shall be UL-tested and certified in accordance with ANSI Z21.47 Standards and UL-listed and certified under Canadian standards as a total package for safety requirements.
   f. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.
   g. Unit casing shall be capable of withstanding 500-hour salt spray exposure per ASTM B117 (scribed specimen).
   h. Unit casing shall be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 5000-hour salt spray.
   i. Unit shall be designed in accordance with ISO 9001:2008, and shall be manufactured in a facility registered by ISO 9001:2008.
   j. Roof curb shall be designed to conform to NRCA Standards.
   k. Unit shall be subjected to a completely automated run test on the assembly line. The data for each unit will be stored at the factory, and must be available upon request.
   l. Unit shall be designed in accordance with UL Standard 1995, including tested to withstand rain.
   m. Unit shall be constructed to prevent intrusion of snow and tested to prevent snow intrusion into the control box up to 40 mph.
   n. Unit shake tested to assurance level 1, ASTM D4169 to ensure shipping reliability.
3. Delivery, Storage and Handling:
   a. Unit shall be stored and handled per manufacturer's recommendations.
   b. Lifted by crane requires either shipping top panel or spreader bars.
   c. Unit shall only be stored or positioned in the upright position.
4. Operating Characteristics:
   a. Unit shall be capable of starting and running at 125°F ambient outdoor temperature, meeting maximum load criteria of AHRI Standard 210/240 or 340/360 at 10% voltage.
   b. Accessory low ambient kits shall be provided.

5. Unit Cabinet:
    a. Unit cabinet shall be constructed of galvanized steel and shall be bonderized and coated with a pre-painted baked enamel finish on all externally exposed surfaces.
    b. Unit cabinet exterior paint shall be: film thickness, (dry) 0.003 inches minimum, gloss (per ASTM D523, 60°F): 60, Hardness: H-2H Pencil hardness.
    c. Evaporator fan compartment interior cabinet insulation shall conform to AHRI Standards 210/240 or 340/360 minimum exterior sweat criteria. Interior surfaces shall be insulated with a minimum 1/2-in. thick, 1 lb density, flexible fiberglass insulation, neoprene coated on the air side. Aluminum foil-faced fiberglass insulation shall be used in the gas heat compartment.
    d. Base of unit shall have a minimum of four locations for thru-the-base gas and electrical connections (factory installed or field installed), standard.
    e. Base Rail
        1) Unit shall have base rails on a minimum of 4 sides.
        2) Holes shall be provided in the base rails for rigging shackles to facilitate maneuvering and overhead rigging.
        3) Holes shall be provided in the base rail for moving the rooftop by fork truck.
        4) Base rail shall be a minimum of 16 gauge thickness.
    f. Condensate pan and connections:
        1) Shall be an internally sloped condensate drain pan made of a non-corrosive material.
        2) Shall comply with ASHRAE Standard 62.
        3) Shall use a 3/4" -14 NPT drain connection, possible either through the bottom or side of the drain pan. Connection shall be made per manufacturer's recommendations.
    g. Top panel:
        1) Shall be a single piece top panel.
    h. Gas Connections:
        1) All gas piping connecting to unit gas valve shall enter the unit cabinet at a single location on side of unit (horizontal plane).
    i. Electrical Connections
        1) All unit power wiring shall enter unit cabinet at a single, factory-prepared, knockout location.
        2) Thru-the-base capability.
            a) Standard unit shall have a thru-the-base electrical location(s) using a raised, embossed portion of the unit basepan.
            b) Optional, factory-approved, water-tight connection method must be used for thru-the-base electrical connections.
            c) No basepan penetration, other than those authorized by the manufacturer, is permitted.
    j. Component access panels (standard)

1) Cabinet panels shall be easily removable for servicing.
2) Unit shall have one factory installed, tool-less, removable, filter access panel.
3) Panels covering control box, indoor fan, indoor fan motor, gas components (where applicable), and compressors shall have a molded composite handles.
4) Handles shall be UV modified, composite. They shall be permanently attached, and recessed into the panel.
5) Screws on the vertical portion of all removable access panel shall engage into heat resistant, molded composite collars.
6) Collars shall be removable and easily replaceable using manufacturer recommended parts.

6. Gas Heat
   a. General
      1) Heat exchanger shall be an induced draft design. Positive pressure heat exchanger designs shall not be allowed.
      2) Shall incorporate a direct-spark ignition system and redundant main gas valve.
      3) Gas supply pressure at the inlet to the rooftop unit gas valve must match that required by the manufacturer.
   b. The heat exchanger shall be controlled by an integrated gas controller (IGC) microprocessor.
      1) IGC board shall notify users of fault using an LED (light-emitting diode).
      2) The LED shall be visible without removing the control box access panel.
      3) IGC board shall contain algorithms that modify evaporator-fan operation to prevent future cycling on high temperature limit switch.
      4) Unit shall be equipped with anti-cycle protection with one short cycle on unit flame rollout switch or 4 continuous short cycles on the high temperature limit switch. Fault indication shall be made using an LED.
   c. Standard Heat Exchanger construction
      1) Heat exchanger shall be of the tubular-section type constructed of a minimum of 20-gauge steel coated with a nominal 1.2 mil aluminum-silicone alloy for corrosion resistance.
      2) Burners shall be of the in-shot type constructed of aluminum-coated steel.
      3) Burners shall incorporate orifices for rated heat output up to 2000 ft (610m) elevation. Furnish and install accessory kits as required for applications above 2000 ft (610m) elevation.
      4) Each heat exchanger tube shall contain multiple dimples for increased heating effectiveness.
   d. Induced draft combustion motor and blower
      1) Shall be a direct-drive, single inlet, forward-curved centrifugal type.
      2) Shall be made from steel with a corrosion-resistant finish.

3) Shall have permanently lubricated sealed bearings.
4) Shall have inherent thermal overload protection.
5) Shall have an automatic reset feature.

7. Coils
   a. Furnish flue extension to exhaust flue cases above the top of the unit to prevent products of combustion from being drawn into the outside air intake.
   b. Standard Aluminum Fin/Copper Tube Coils:
      1) Standard evaporator and condenser coils shall have aluminum lanced plate fins mechanically bonded to seamless internally grooved copper tubes with all joints brazed.
      2) Evaporator coils shall be leak tested to 150 psig, pressure tested to 450 psig, and qualified to UL 1995 burst test at 1775 psig.
      3) Condenser coils shall be leak tested to 150 psig, pressure tested to 650 psig, and qualified to UL 1995 burst test at 1980 psig.
8. Refrigerant Components:
   a. Refrigerant circuit shall include the following control, safety, and maintenance features:
      1) Thermostatic Expansion Valve (TXV) shall help provide optimum performance across the entire operating range. Shall contain removable power element to allow change out of power element and bulb without removing the valve body.
      2) Refrigerant filter drier - Solid core design.
      3) Service gauge connections on suction and discharge lines.
      4) Pressure gauge access through a specially designed access port in the top panel of the unit.
   b. There shall be gauge line access port in the skin of the rooftop, covered by a black, removable plug.
      1) The plug shall be easy to remove and replace.
      2) When the plug is removed, the gauge access port shall enable maintenance personnel to route their pressure gauge lines.
      3) This gauge access port shall facilitate correct and accurate condenser pressure readings by enabling the reading with the compressor access panel on.
      4) The plug shall be made of a leak proof, UV-resistant, composite material.
   c. Compressors
      1) Unit shall use fully hermetic, scroll compressor for each independent refrigeration circuit.
      2) Units shall be available with single compressor/single stage cooling.
      3) Compressor motors shall be cooled by refrigerant gas passing through motor windings.
      4) Compressors shall be internally protected from high discharge temperature conditions.
      5) Compressors shall be protected from an over-temperature and over-amperage conditions by an internal, motor overload device.

6) Compressor shall be factory mounted on rubber grommets.
7) Compressor motors shall have internal line break thermal, current overload and high pressure differential protection.
8) Crankcase heaters shall not be required for normal operating range, unless provided by the factory.

9. Filter Section:
   a. Filters shall be held in place by a pivoting filter tray, facilitating easy removal and installation.
   b. Shall consist of factory-installed, low velocity, throw-away 2-in. thick fiberglass filters.
   c. Filters shall be standard, commercially available sizes.
   d. Only one size filter per unit is allowed.
10. Evaporator Fan and Motor:
   a. Evaporator fan motor:
      1) Shall have permanently lubricated bearings.
      2) Shall have inherent automatic-reset thermal overload protection or circuit breaker.
      3) Shall have a maximum continuous bhp rating for continuous duty operation; no safety factors above that rating shall be required.
   b. Belt-driven Evaporator Fan:
      1) Belt drive shall include an adjustable-pitch motor pulley.
      2) Shall use sealed, permanently lubricated ball-bearing type.
      3) Blower fan shall be double-inlet type with forward-curved blades.
      4) Shall be constructed from steel with a corrosion resistant finish and dynamically balanced.
11. Condenser Fan Motors
   a. Shall be a totally enclosed motor.
   b. Shall use permanently lubricated bearings.
   c. Shall have inherent thermal overload protection with an automatic reset feature.
   d. Shall use a shaft-down design with rain shield.
   e. Condenser Fans:
      1) Shall be a direct-driven propeller type fan.
      2) Shall have aluminum blades riveted to corrosion-resistant steel spiders and shall be dynamically balanced. Special Features Options and Accessories:
12. Integrated Economizers: The return air damper shall be locked in the closed position and the outside air damper shall be interlocked to open when the makeup air unit fan runs.):
   a. Integrated, gear-driven parallel modulating blade design type capable of simultaneous economizer and compressor operation.
   b. Damper blades shall be galvanized steel with composite gears. Plastic or composite blades on intake or return shall not be acceptable.
   c. Shall include all hardware and controls to provide free cooling with outdoor air when temperature and/or humidity are below setpoints.
   d. Shall be equipped with gear driven dampers for both the outdoor ventilation air and the return air for positive air stream control.

e. Shall be equipped with low-leakage dampers, not to exceed 2% leakage at 1 in. wg pressure differential.
f. Shall be capable of introducing up to 100% outdoor air.
g. Shall be designed to close damper(s) during loss-of-power situations with spring return built into motor.
h. Dry bulb outdoor-air temperature sensor shall be provided as standard. Outdoor air sensor setpoint shall be adjustable and shall range from 40 to 100°F.
i. Gravity economizer relief.
j. The economizer shall maintain minimum airflow into the building during occupied period and provide design ventilation rate for full occupancy. A remote potentiometer may be used to override the damper setpoint.
k. Dampers shall be completely closed when the unit is in the unoccupied mode.
l. close closes at 50°F.
m. Actuator shall be direct coupled to economizer gear.
n. Economizer controller shall provide indications when in free cooling mode or in the DCV mode.
o. Flue gas extension kit designed to exhaust product of combustion at or above top of unit.

13. Head Pressure Control Package
    a. Controller shall control coil head pressure by condenser-fan speed modulation or condenser-fan cycling and wind baffles.
    b. Shall consist of solid-state control and condenser-coil temperature sensor to maintain condensing temperature between 90°F and 110°F at outdoor ambient temperatures down to -20°F.
14. Flue Shield
    a. Flue shield shall provide protection from the hot sides of the gas flue hood.
15. Condenser Coil Hail Guard Assembly
    a. Shall protect against damage from hail.
    b. Shall be of louvered style.
16. Unit-Mounted, Non-Fused Disconnect Switch:
    a. Switch shall be factory-installed, internally mounted.
    b. National Electric Code (NEC) and UL approved non-fused switch shall provide unit power shutoff.
    c. Shall be accessible from outside the unit.
    d. Shall provide local shutdown and lockout capability.
17. Convenience Outlet:
    a. Non-Powered convenience outlet.
        1) Outlet shall be powered from a separate 115/120v power source.
        2) A transformer shall not be included.
        3) Outlet shall be factory-installed and internally mounted with easily accessible 115-v female receptacle.
        4) Outlet shall include 15 amp GFI receptacles with independent fuse protection.
        5) Outlet shall be accessible from outside the unit.

6) Outlet shall include a field-installed “Wet in Use” cover.

18. Thru-the-Base Connectors:
    a. Kits shall provide connectors to permit gas and electrical connections to be brought to the unit through the unit basepan.
    b. Minimum of four connection locations per unit.
19. Economizer Relief:
    a. Power Exhaust Fan.
20. Roof Curbs (Vertical):
    a. Re-use existing curb, furnish and install seismically rated hold down clips.
21. High Altitude Gas Conversion Kit:
    a. Package shall contain all the necessary hardware and instructions to convert a standard natural gas unit to operate from 2000-7000 ft (610 to 2134m) elevation with natural gas.
22. Smoke Detectors:
    a. Devices: Smoke detection devices shall be factory supplied and installed in the return air streams on all units supplying greater than 2,000 cfm.
    b. Smoke Detectors shall be Honeywell Model TC805B or System Sensor DH400ACDC with metal sampling tubes. Contractor to verify compatibility with the existing fire alarm system. Wire the detectors serving each air handling system into the fire alarm panel. Smoke detection shall shut down fan system on smoke detection.
23. Time Guard
    a. Shall prevent compressor short cycling by providing a 5-minute delay before restarting a compressor after shutdown for any reason.
    b. One device shall be required per compressor.
24. Hinged Access Panels:
    a. Shall provide easy access through integrated quarter turn latches.
    b. Shall be on major panels – filter, control box, fan motor and compressor.
25. Supply Fan Variable Frequency Drives:
    a. Provide supply fan with a factory wired VFD with features and characteristics in compliance with that described in Section 230513.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which packaged rooftop units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF PACKAGED ROOFTOP UNITS:

A. General: Install packaged rooftop units where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.

B. Coordination: Coordinate with other work, including ductwork, roof decking, gas piping, and electrical as necessary to interface installation of rooftop units with other work.

C. Access: Provide access space around packaged rooftop units for service as indicated, but in no case less than that recommended by manufacturer.

D. Mounting: Mount rooftop units on a seismic curb, in accordance with manufacturer's instructions.

E. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
   1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

F. Duct Connections: Refer to Division-23 Air Distribution sections. Provide ductwork, accessories, and flexible connections as indicated.

G. Grounding: Provide positive equipment ground for rooftop unit components.

H. Coil Condensate Drain Trap: Provide coil condensate drain trap of proper size and depth for each side of the rooftop unit coil condensate drain pan.

3.3 FIELD QUALITY CONTROL:

A. Testing: Upon completion of installation of packaged rooftop units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units, then retest to demonstrate compliance. Provide manufacturer’s startup service

B. If specified conditions cannot be obtained due to deficiencies in equipment performance or improper installation or workmanship, the Mechanical Contractor and his subcontractors shall make any changes necessary to obtain the specified conditions.

3.4 EXTRA STOCK:

A. Provide one complete extra set of pre-filters for each packaged rooftop unit. Install new filters at completion of rooftop unit work, and prior to testing, adjusting, and balancing work. Obtain receipt from Owner that new filters have been installed.

B. Provide one spare set of belts for each belt-driven packaged rooftop unit, obtain receipt from Owner that belts have been received.

END OF SECTION

SECTION 23 81 26
SPLIT SYSTEM AIR CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install heat pumps as described in Contract Documents.
B. Related Sections:
   1. Division: Concrete pads.
   2. Section 23 00 00: General Mechanical Requirements.

1.2 SUBMITTALS

A. Quality Assurance / Control: Equipment check-out sheets.

1.3 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Each unit shall be UL / ULC or ETL labeled.

1.4 WARRANTY

A. Provide five-year warranty on compressors beginning from date of start-up. Record start-up date on warranty certificate for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Heat Pumps:
   1. Indoor Units:
      a. Wall mounted units as scheduled.
      b. Isolate moving parts from cabinets to reduce noise.
   2. Outdoor Units:
      a. Fans shall be direct driven and discharge horizontally.
      b. Casings shall be fully weatherproof for outdoor installations.
      c. Microprocessor Controls shall be factory wired with field installed remote pendant station.
      d. Refrigerant shall be R-410a.
      e. Factory installed refrigerant circuits shall be provided with reversing valves to provide heating function down to 5°F or lower
      f. Isolate moving parts from cabinets to reduce noise.
      g. Use dry-charged tubing for connection of unit's refrigerant system.
   3. Accessories:
      a. Provide all indoor units with wired remote controllers or wireless remote controllers installed in secure housings.

4. In addition to that specified above, provide heat pump split systems with all standard features to match features of those scheduled.
5. Approved Manufacturers:
    a. Daikin Air Conditioning (Americas) Inc, Carrollton, TX www.daikinac.com.
    b. Carrier Corp, Syracuse, NY www.commercial.carrier.com.
    c. Friedrich Air Conditioning Co, Austin, TX www.friedrich.com.
    d. Mitsubishi Electronics America Inc, HVAC Div, Norcross, GA www.mrslim.com.
    e. Sanyo Air Conditioning Products, Chatsworth, CA www.sanyo.com.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Units shall be started up, checked out, and adjusted by Unit Manufacturer's authorized factory trained service mechanic. Use equipment check-out sheet provided by Manufacturer. Complete and sign all items on sheet.

END OF SECTION

SECTION 23 82 41
ELECTRIC UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
1. Furnish and install electric heaters as described in Contract Documents.

B. Related Sections:
1. Section 23 00 00: General Mechanical Requirements.
2. Division 26: Electrical service and connections.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Unit heaters shall be UL listed and comply with NEC requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Electric Wall Heaters (EWH-X).
1. Low profile commercial fan forced type for recess mounting in wall for unit.
2. 20 ga. minimum sheet metal casing.
3. Heating elements shall be encased in steel finned casting and protected by thermal switch.
4. Fan motors shall be heavy duty enclosed and permanently lubricated.
5. Fans shall be precision balanced and fan-motor assembly mounted to be vibration free.
6. Units shall be controlled automatically by integral thermostat when heater is in 'ON' position.
7. Heater shall have built-in fan delay.
8. Unit shall have an extruded aluminum front frame.
9. Performance Standard: 4400 Series and 4800 Series by TPI, Markel.
10. Category Four Approved Manufactures. See Section 01 6200 for definitions of categories.
    a. Markel Prod. Co., TPI Corporation, Johnson City, TN www.markel-products.com.
    b. Raywall, TPI Corporation, Johnson City, TN www.raywall.com.
    c. Berko, Marley Electric Co, Bennettsville. SC www.berkomeh.com.
    d. QMark, Marley Electric Co, Bennettsville, SC www.qmarkmeh.com.
    e. Brasch Manufacturing Co, Maryland Heights, MO www.braschmfg.com.
    f. INDEECO, St Louis, MO www.indeeco.com
    g. Heatrex

B. Electric Cabinet Heaters (ECH-X)

1. General: Provide each cabinet heater with the cabinet style, size and capacity schedule on drawings. Install in locations as indicated, and having accessories as scheduled. Include in basic unit chassis, coil, fanboard, fan wheels, housings, filter rails, motor, electric junction box and insulation.
2. Chassis: Galvanized steel wrap-around structural frame with edges flanged. Configuration as indicated on drawings.
3. Insulation: Faced, heavy density glass fiber.
4. Cabinet: 16-ga removable front panel. Insulate front panel over entire coil section. Provide access door on coil connection side and for motor control. Clean cabinet parts, bonderize, phosphatize, and flow-coat with baked-on primer.
5. Heating Element: Element shall be provided with overheat protection.
6. Fans: Provide centrifugal, forward curved double width fan wheels. Construct fan scrolls of galvanized steel.
7. Motors: Provide shaded pole motors with integral thermal over-load protection, and motor cords for plug-in to junction box in unit. Motors shall be permanently lubricated.
8. Motor Speed Control: Solid state, multi-speed with "off" position, unit mounted.
9. Filters: Provide 1" thick throwaway type filters in fiberboard frames.
10. Controls: Furnish unit with factory mounted fan speed switch and thermostat for wall mounting.
11. Unit color to be as selected by Architect. Furnish paint samples for selection.
12. Manufacturer: Subject to compliance with requirements, provide cabinet heaters of one of the following:
    a. Markel
    b. Trane
    c. Williams
    d. Sigma
    e. Berko
    f. Raywall

PART 3 - EXECUTION

A. Install in accordance with manufacturer's instructions.

B. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.

END OF SECTION

SECTION 23 83 00
GAS FIRED UNIT HEATERS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification sections apply to work of this section.

B. All pertinent sections of Section 23 00 00 - General Mechanical Requirements are a part of the work described in this section.

1.2 SUMMARY:

A. Includes but not limited to:
1. Natural gas fired unit heaters

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of Gas Fired Heating systems with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
1. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects with radiant heating systems.

B. The total heating system shall be design certified by the American Gas Association, and each burner shall be affixed with a nameplate that bears the seal of the American Gas Association.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING:

A. Store radiant heater components in a clean dry place. Protect from weather, dirt, fumes, water, and construction debris, and physical damage.

1.5 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for fuel fired heating systems showing dimensions, weights, ratings, fan performance, motor electrical characteristics, and finishes of materials, and installation instructions.

B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, weight loadings, required clearances, construction details, and field connection details.
1. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to radiant heating systems. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate

between portions of wiring that are factory-installed and portions to be field-installed.

2. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals; in accordance with requirements of Division 23.

PART 2 – PRODUCTS

2.1 GAS FIRED UNIT HEATERS (UH-1):

A. High Efficiency natural gas-fired unit heaters with separated combustion, axial fan, power vented high efficiency.

B. The unit input capacity shall be as listed on the plans. The output capacity shall be a minimum of 93% of the input based on steady-state thermal efficiency as certified by the American Gas Association (A.G.A.)

C. Size and capacity as scheduled on the drawings.

D. Casing: Casing shall be 22 gauge cold rolled steel draw-formed with a baked on enamel finish, aesthetically designed with rounded corners, and fitted to eliminate exposed fasteners. Casing shall also include a hinged bottom panel for easy access to the burner compartment. Horizontal air deflector louvers shall be provided to aid in controlling the discharge air pattern

E. Burner: The burner(s) shall be in-shot type, directly firing each heat exchanger tube individually and is designed for good lighting characteristics without noise of extinction for both natural and propane gas

F. Heat Exchanger: The heat exchanger(s) shall be made of 18 gauge aluminized steel tubes and headers. Each heat exchanger tube shall be individually and directly flame-fired. The heat exchanger tube shall be crimped to allow for thermal expansion and contraction. The flue collector box shall be made of 20 gauge AL29-4C stainless steel.

The thermal efficiency of the unit(s) shall be a minimum of 93% efficient for all air flow ranges through the use of a secondary recuperative heat exchanger. The secondary heat exchanger shall be constructed of AL29-4C stainless steel to withstand the corrosive environment of condensing gas fired equipment.

The heat exchanger(s) seams and duct connections shall be certified to withstand 0.9" W.C. external static pressure without burner flame disturbance

G. Venting: The unit shall be separated combustion. The venting shall be a power exhausted arrangement with a separate combustion air intake pipe connection to allow for fresh combustion air from outside the conditioned space. The unit shall be tested to ensure proper ignition when the unit is subjected to 40 mile per hour wind

velocities. The unit shall also include a factory mounted differential pressure switch designed to prevent main burner ignition until positive venting has been proven.
1. Venting shall be Schedule 40 PVC.

H. Controls: Shall be factory wired and tested microprocessor based with the following features and safeties: hot surface ignition system, redundant gas control valves, with on-off knob or switch, multi speed combustion induction fan, combustion fan airflow proving switch, manual reset flame rollout safety switch, limit controls, wiring junction box, control box, solid state fan controls, limit controls, transformer, etc.

I. Motor and Propeller Fan: Each unit heater shall have a single motor and propeller. Motor shall be totally enclosed with thermal overload protection (single phase only). Propeller shall be statically balanced and shall be equipped with a safety fan guard.

J. Manufacturer
1. Reznor
2. Modine
3. Trane
4. Sterline

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which gas fired heating systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF GAS FIRED UNIT HEATERS:

A. General: Install gas fired unit heaters as indicated and in accordance with manufacturer's published installation instructions. Mount such that tubing slopes or run level per manufacturers requirements.

B. Provide and install all low voltage (below 120 volt) control wiring and accessories complete, as specified.

C. Power wiring by electrical not work of this division.

D. Extend condensate drain piping from vacuum pump and combustion chamber to an approved drainage fixture through the use of no less than 3/4" copper piping.

E. Extend gas piping to units, provide drop with manual gas shutoff valve, pressure reducing valve, plugged test connection, tee and drip pocket. Locate piping drop so as not to interfere with service of unit. Extend gas piping runout, full size of gas train inlet, from tee to gas train connection, provide union with sufficient clearance for unit removal and service.

3.3 START-UP:

A. Furnace distributors technical service representative shall start up and check out furnace equipment as follows:
   1. Verify proper gas orifice sizing.
   2. Clock gas meter for rated output.
   3. Verify and set gas pressure at unit.
   4. Measure and record temperature rise.
   5. Check safety controls for proper operation.
   6. Check vent and combustion air sizes and performance.

3.4 OPERATION AND MAINTENANCE TRAINING:

A. Provide services of manufacturer's service representative to instruct Owner's personnel in operation and maintenance of gas fired furnaces. Training shall include start-up and shut-down servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance. Review operating and maintenance data contained in the Operating and Maintenance Manuals section.
   1. Schedule training with Owner, provide at least 7-day prior notice to the Architect/Engineer.
   2. Vendors for each piece of equipment controls, etc., shall participate along with the contractor(s).

END OF SECTION

DIVISION 26
ELECTRICAL

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SECTION 26 00 00
ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide electrical and appurtenant Work necessary for a complete and operable electrical system, in accordance with the Contract Documents.

B. Make all field connections and terminations to all motors, switchgear, panels, control equipment and devices, instruments, and to all vendor-furnished packaged equipment. The requirements of this Section shall apply to all electrical items indicated in the various Sections of Division 26 unless otherwise indicated.

C. Provide all materials and incidentals required to complete the electrical Work. Typical materials which may be incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and all control wires required by vendor-furnished equipment to interconnect with other equipment all specifically indicated on the Contract Documents.

D. All concrete Work required for encasement, installation, or construction of the Work specified in the various Sections of Division 26 shall be 3,000-psi concrete conforming to the applicable requirements of Section 03 30 00 - Cast-in-Place Concrete:
   1. If encasement concrete around duct banks is required, the following exceptions and supplementary requirements shall apply:
      a. Consolidation of encasement concrete around duct banks shall be by hand puddling, and no mechanical vibration shall be permitted.
      b. A Workability admixture shall be used in encasement concrete, which shall be a hydroxylated carboxylic acid type in liquid form. Admixtures containing calcium chloride shall not be used.
      c. Concrete for encasement of conduit or duct banks shall contain an integral red-oxide coloring pigment in the proportion of 8 pounds per cubic yard of concrete.

1.2 INTERFACE TO EQUIPMENT, INSTRUMENTS, AND OTHER COMPONENTS:

A. The contract drawings, specifications, and overall design are based on non-certified information furnished by various equipment manufacturers. This “equipment” includes, but not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.

B. The electrical specifications, ladder logic diagrams, and installation details are based on non-certified vendor information and indicate minimum scope of supply from Manufacturers.

C. Include all labor, material, and others costs in the bid to add additional instrument, wiring, control system inputs/outputs, controls, conduit, interlocks, electrical hardware, etc., into the Work based on the Equipment Manufacturer’s final certified Drawings.

D. Revise or produce new loop diagrams to meet the Equipment Manufacturer's wiring requirements.

E. Incorporate such changes to Instrumentation and Electrical Work at no additional cost to the Owner considering the Contractor's knowledge that non-certified vendor information has been used in the design, and due to the fact that the final selection of the vendor may have been by the Contractor.

F. Submit all such changes and additions to the Engineer for acceptance before starting field installation Work.

G. The Contractor is responsible for providing all material and labor needed to install the actual equipment furnished, as such the Contractor's bid includes all costs to add any additional conduit, wiring, terminals, or other electrical hardware to the design, which may be necessary to make a complete, functional installation based on the actual equipment furnished:
   1. Make all changes necessary to meet the Manufacturer's wiring requirements.
   2. Incorporate such changes to the electrical installation into the final "As-Built" Drawings.

H. Review the complete set of Drawings and Specifications in order to ensure that all items related to the electrical power and control systems are completely accounted for. Include any such items that appears on Drawings or Specifications from another discipline in the scope of Work and any costs for these items.

I. Loop drawings. Provide complete Loop Drawings for all systems, including packaged equipment furnished as part of a Vendor furnished package, and for all pre-purchased equipment.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes and Standards

NFPA 30	Flammable and Combustible Liquids Code.
NFPA 37	Installation and Use of Stationary Combustion Engines and Gas Turbines.
NFPA 70	National Electrical Code, latest edition.
NFPA 99	General Overall Requirements.
NFPA 110	Emergency and Standby Power Systems.

B. Government Standards

FS W-C-596E/GEN(1)	Connector, Plug, Receptacle and Cable Outlet, Electrical Power
FS W-S-896E/GEN(1)	Switches, Toggle (Toggle and Lock), Flush Mounted (ac)
FS WW-C-563	Electrical Metallic Tubing (EMT)

FS WW-C-581D, E	Conduit, Metal, Rigid, and Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit: Steel, Zinc Coated
OSHA	Safety and Health Standards, 29 CFR 1910 and 29 CFR 1926 as applicable

C. Commercial Standards

ANSI C80.1	Zinc Coated, Rigid Steel Conduit, Specification for
ANSI C80.4	Fittings for Rigid Metal Conduit and Electrical Metallic Tubing, Specifications for
ANSI/UL 467	Grounding and Bonding Equipment, Safety Standard for
ASTM B 3	Soft or Annealed Copper Wire
ASTM B 8	Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, and Soft
ASTM B 33	Specification for Timed Soft or Annealed Cooper Wire for Electrical Purposes
ICEA S-61-402	Thermoplastic - Insulated Wire and Cable
ICEA S-66-524, NEMA WC7	Cross-Linked, Thermosetting, Polyethylene Wire and Cable
ICEA S-68-516, NEMA WC8	Ethylene Propylene Rubber Insulated Wire and Cable
NEMA 250	Enclosures for Electrical Equipment (1,000 volts maximum)
NEMA PB-1	Panelboards
NEMA VE-1	Ventilated Cable Tray
UL 6	Rigid Metal Electrical Conduit
UL 44	Rubber - Insulated Wire and Cable.
UL 514	Electrical Outlet Boxes and Fittings
UL 886	Electrical Outlet Boxes and Fittings for Use in Hazardous Locations

D. All equipment furnished by the Contractor shall be listed by and shall bear the label of Underwriters' Laboratories, Incorporated, (UL) or an independent testing laboratory acceptable to the local Code-enforcement agency having jurisdiction.

E. The construction and installation of all electrical equipment and materials shall comply with all applicable provisions of the OSHA Safety and Health Standards (29CFR1910 and

29CFR1926, as applicable), State Building Standards, and applicable local codes and regulations.

1.4 PUBLIC UTILITIES REQUIREMENTS

A. Contact the serving agencies and verify compliance with their requirements before construction.

B. Electrical service shall be as indicated by the Contract Documents.

C. Verify, furnish, and install all service conduits, fittings, transformer pad, grounding devices, and all service wires not furnished by the serving utility.

D. Verify with the utility the exact location of each service point and type of service, and pay all charges levied by the serving utilities without additional cost to the Owner.

1.5 PERMITS AND INSPECTION

A. Permits shall be obtained, and inspection fees shall be paid for as indicated in Section 00 70 00 - General Conditions.

B. Pay for any service charges required by the utility company for connection and turn on.

1.6 CONTRACTOR SUBMITTALS

A. Shop Drawings and Catalog Data: Submit shop drawings and catalog data submittals in accordance with Section 01 33 20 – Submittal Procedures.

B. Submit complete material lists for the Work of this Section. Such lists shall state manufacturer and brand name of each item or class of material. Submit shop drawings for all grounding Work not specifically indicated.

C. Shop drawings are required for materials and equipment listed in other sections. Shop drawings shall provide sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications. The following shall be included:
   1. Front, side, rear elevations and top views with dimensional data.
   2. Location of conduit entrances and access plates.
   3. Component data.
   4. Connection diagrams, terminal numbers, wire numbers, internal wiring diagrams, conductor size, and cable numbers.
   5. Method of anchoring, seismic requirement; weight.
   6. Types of materials and finish.
   7. Nameplates.
   8. Temperature limitations, as applicable.
   9. Voltage requirement, as applicable.
   10. Front and rear access requirements.

D. Catalog data shall be submitted to supplement all shop drawings. Catalog cuts, bulletins, brochures, or the like or photocopies of applicable pages thereof shall be submitted for mass

produced, noncustom manufactured material. These catalog data sheets shall be stamped to indicate the project name, applicable Specification section and paragraph, model number, and options. This information shall be marked in spaces designated for such data in the stamp.

E. Materials and Equipment Schedules: Furnish within 30 days, a complete list of all materials, equipment, apparatus, and fixtures proposed for use. The list shall include type, sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.

F. O&M Manuals: Furnish manuals as part of the shop drawing submittals under "Operation and Maintenance Manuals" in Section 01 33 20 – Submittal Procedures.

G. Record Drawings: In addition to the record drawings as a part of the record drawing requirements specified in Section 01 33 20 – Submittal Procedures, show depths and routing of all duct bank concealed below grade electrical installations. Said set of record drawings shall be available to the Engineer during construction. After final inspection, transfer all record drawing information using a red pen to a set of drawings which shall then be delivered to the Engineer. In addition, the record drawings shall show all variations between the Work as actually constructed and as originally shown on the Drawings, based upon information supplied by the Contractor.

H. Submittal organization:
   1. First page:
      a. Specification Section Reference.
      b. Name and telephone number of individual who reviewed submittal before delivery to Engineer.
      c. Name and telephone number of individual who is primarily responsible for the development of the submittal.
      d. Place the Contractor‘s review stamp and comments.
   2. Next pages:
      a. Provide confirmation of Specification compliance in tabular form that individually lists each Specification section, paragraph, and subparagraph and unequivocally states compliance with said requirement or takes exception to the requirement and lists the reason for said exception and offers alternative means for compliance.
      b. Include a response in writing with each submittal packages which is re-submitted to each of the Engineer’s comments or questions:
         1) In the order that the comments and/or questions were presented throughout the submittal.
         2) Referenced by index section and page number on which the comment appeared.
         3) Acceptable responses to Engineer’s comments are either: (1) Engineer’s comments or change is accepted and appropriate changes are made or (2) Explain why comment is not accepted or requested change is not made, (3) Explain how requirement will be satisfied in lieu of comment or change requested by Engineer.
      c. Any re-submittal, which does not contain responses to the Engineer’s previous comments shall be returned for Revision and Resubmittal.

d. No further review by the Engineer will be performed until a response for previous comments has been received.

3. Remaining pages:
   a. Actual submittal data:
      1) Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the Specification Section.
      2) For Submittals that cover multiple devices used in different areas under the same Specification Section, the Submittal for the individual devices must list the area where the device is intended to be used.
   b. Advise all Equipment Suppliers of submittal requirements outlined in Section 01 33 20.
   c. Use equipment and instrument tags, as depicted on the P&IDs, for all submittals.

I. Engineer's review:
   1. The Engineer has allowed for up to and including 2 reviews of each submittal. The time and expense for any reviews beyond the allotted 2 reviews will be borne by the Contractor. Reference 01 33 20.

J. Material and Equipment Schedules:
   1. Deliver to the Engineer a complete schedule and/or matrix of all materials, equipment, apparatus, and luminaries proposed for use, including sizes, names of Manufacturers, catalog numbers, and such other information required to identify the items.

K. Schedule of Values:
   1. In addition to completing all items referred to in the schedule of values, Section 01 29 73, submit per unit material and labor costs used in developing the final bid for the electrical system, for the express purpose of pricing and cost justification for any proposed change orders. In addition to the items shown on the schedule of values, provide per unit material and labor costs for conduit and wire installation for specific types, sizes, and locations as indicated on the Drawings and Conduit Schedule. It is the responsibility of the Electrical Contractor to prove to the Engineer's satisfaction that these per unit costs were used in the development of the final bid amount. The Owner will withhold all progress payments until said schedule of values is provided and accepted by the Engineer.

L. Roof Penetrations:
   1. Submit details of all portions of the electrical installation that penetrate the roof. Include details showing support of the penetrating component, and the sealing means to be utilized.

M. Installation Recommendations:
   1. Submit the Manufacturer's printed recommendations for installation of electrical equipment.

N. Record Drawings:
   1. Furnish in accordance with Section 01 78 39.

2. Electrical Drawings will be provided for the express purpose of being used for the Record Drawings. Maintain shop drawings for use as Record Drawings:
    a. Update Record Drawings weekly.
    b. Record Drawings must be fully updated as a condition of the monthly progress payments.
    c. Submit Record Drawings upon completions of the project for final review.
3. Clearly and neatly show all changes;
    a. Additions or changes marked in red.
    b. Deletions marked in green.
    c. Comments marked in blue.
    d. Installed systems in yellow.
    e. Invert elevations of conduit and depth below grade or floor line.
    f. Dimensions of equipment.
    g. Exact locations of equipment, underground and concealed conduit, and ductbanks.
4. Dimensioned with reference to the structures
    a. All existing pipe, conduit, wire, instruments or other structures encountered or uncovered during construction.
5. Upon completion of the Work, update all shop drawings to indicate the final As-Built configuration of the systems;
    a. Reference Section 01 33 20 for specific requirements.
    b. Provide As-Built shop drawings for all electrical equipment in accordance with Section 01 33 20.
    c. Provide electronic copies of these documents when required in Division 01 33 20.
6. Furnish manuals, or portions thereof, written specifically for this project.
    a. Provide electronic copies of these documents on CD-ROM disks as required in division 01 33 20.

O. O. Specific Submittal Requirements:
1. Furnish the submittals required by each Section in Division 26 in accordance with the following requirements.
2. Shop Drawings
    a. Required for materials and equipment listed in this and other Sections.
    b. Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications.
    c. Shop Drawings requirements:
        1) Front, side, and rear elevations, and top and bottom views, showing all dimensions.
        2) Locations of conduit entrances and access plates.
        3) Component layout and identification.
        4) Schematic and wiring diagrams with wire numbers and terminal identification.
        5) Connection diagrams, terminal diagrams, internal wiring diagrams, conductor size, etc.
        6) Anchoring method and leveling criteria, including Manufacturer's recommendations of the seismic conditions specified in Section 01 81 10.

7) Weight.

P. Calculations:
1. All required calculations to be stamped and sealed by a Professional Engineer registered in the State where the project is being constructed and specializing in the specific area required by the calculation.
2. By virtue of the fact that these calculations are being provided by a Registered Professional Engineer, they will be reviewed for form, format, and content but will not be reviewed for accuracy and calculations means.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements.
1. Perform all Work to meet the requirements of all legally constituted authorities having jurisdiction.
2. Perform all Electrical Work, whether needed for the power, control system, process, HVAC, telephone, security, etc. in accordance with all codes and standards required by Division 26.
3. Perform all Work so as to comply with the accepted editions, amendments, practices, and rulings of the applicable codes and standards, except where the Drawings and Specifications are more stringent.

B. System Supplier Responsibilities:
1. In accordance with the requirements of Division 40.
2. System Supplier: Due to the critical and complex technical requirements of this project, furnish all the systems specified in Division 26 and Division 40, through a single System Supplier, who shall have single source responsibility for the entire instrumentation, control, and electrical power systems.
3. Contractual Relationship:
   a. Form a contractual relationship between the Electrical Contractor and the Instrumentation & Control System Contractor.
   b. Requirements for the first tier Contractor:
      1) Contract directly with the CONTRACTOR
      2) Be either the Electrical Contractor or the Instrumentation & Control System Contractor
      3) Be defined as the System Supplier.
   c. Requirements for the second tier Contractor:
      1) A Division of the first tier Contractor, or
      2) A joint venture with the first tier Contractor, or
      3) A sub-Contractor to the first tier Contractor.
   d. The System Supplier manages, directs, and supervises all of the Work of its second tier Contractor. The System Supplier is solely responsible for the entire electrical and instrumentation system, including, but not limited to, all electrical, instrumentation, and process Contract Drawings, Division 40 and Division 26:
      1) Provide any additional conduit, wire, etc.
   e. Provide any additional I/O, programming, screens, interface devices needed by the System Supplier are to be installed by the Electrical Contractor or the

Instrumentation and Control Systems Contractor, under the above outlined Working agreement.

1.8 DELIVERY, STORAGE, AND PROTECTION

A. Acceptance of material and equipment Furnished By Others (F.B.O.):
   1. Where equipment or materials are to be F.B.O. to the Contractor for installation and connection, the Contractor must:
      a. Upon receiving such equipment or materials, make a complete check of all items and provide a transfer of materials document.
      b. Provide the transfer of materials document as a receipt detailing the products received and the condition of the products delivered to the Contractor.
      c. After Receiving and accepting the material, assume full responsibility for the safe keeping, handling, and the installation of the materials and equipment, until completed installation and final acceptance by the Engineer.
   2. Failure to issue said receipt assumes that all equipment and materials were then delivered to the Contractor in the proper quantities and in perfect condition.

B. Storage and Protection:
   1. Provide for the safe storage and delivery of materials, whether furnished by the Contractor or by others.
   2. Replace all equipment or material, damaged before final acceptance by the Engineer in a manner acceptable to the Engineer.
   3. Meet all storage requirements of the Manufacturer and provide for the safe storage of all materials and equipment as recommended by the Manufacturer.
   4. Protect electrical Work at all times from damage, defacement or deterioration from any cause whatever:
      a. Provide proper storage facilities and conduct operations to this effect.
      b. Perform electrical Work in a manner as to protect the Work of other trades.

1.9 PROJECT OR SITE CONDITIONS

A. Site Conditions:
   1. Provide an electrical, instrumentation and control system, including all equipment, raceways and any other components required for a complete installation that meets the Environmental conditions for the Site as specified in the General Requirements and below.
   2. Seismic Classification:
      a. Provide all electrical equipment and construction techniques suitable for the seismic requirements for the Site, as specified in Section 01 81 10.
   3. Wind:
      a. Provide all electrical equipment and construction techniques suitable for the Site wind loading criteria, as specified in Section 01 81 11.
   4. Altitude:
      a. The site is located at approximately 5,880 feet above mean sea level. Provide all electrical components and equipment fully rated for continuous operation at this altitude, with no additional derating factors applied.
   5. Humidity:

a. The facility is located in an area where the relative humidity is 100 percent non-condensing. Furnish all components and equipment fully rated for continuous operation at this relative humidity level.

6. Temperature:
   a. The facility is in an area where the temperature will vary from a minimum of 31 degrees Fahrenheit to a maximum of 102 degrees Fahrenheit.
   b. Provide additional temperature conditioning equipment to maintain all equipment in non-conditioned spaces subject to these ambient temperatures 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature as determined by the equipment Manufacturer's guidelines.
7. Outdoor installations:
   a. Provide all electrical, instrumentation and control equipment installed outdoors that are suitable for operation in the ambient conditions where the equipment is located.
   b. Provide heating, cooling, and de-humidifying devices incorporated into and included with electrical equipment, instrumentation and control panels located outdoors in order to maintain the enclosures within the rated environmental operating ranges as specified in this Paragraph for the equipment:
      1) Provide all wiring necessary to power these devices.
8. Site Security:
   a. Abide by all security and safety rules concerning the Work on the Site, as specified in Section 01 35 53.

1.10 AREA DESIGNATIONS

A. General:
   1. For purposes of delineating electrical enclosure and electrical installation requirements of this project, certain areas have been classified in the Contract Documents as defined below. Electrical installations within these areas shall conform to the referenced code requirements for the area involved.

B. Electrical Work Requirements by Area:
   1. Unless otherwise specifically indicated on the Drawings or in the Conduit Schedule enclosures, conduits and Electrical Work shall be in accordance with Table 1 and requirements 1.10 C-G:

Table 1 Plant Area Electrical Work Requirements

PLANT AREA	NEMA ENCLOSURE TYPE							CONDUIT TYPE				NOTES
	1	3R	4	4X	7	9	12	PVC	EMT	GRC	PCS	
Treatment Room							X			X		PVC conduit where concealed
Mounted on treatment tanks				X				X			X	Where not exposed to damage PVC is acceptable

Electrical Room	X									X		PVC conduit where concealed
Blower Room	X									X		PVC conduit where concealed
Utility Room	X									X		PVC conduit where concealed
Pump Room							X			X		PVC conduit where concealed
Garage/Shop							X					PVC conduit where concealed
Office/Finished Areas	X									X		PVC or EMT where concealed
Sludge Basins				X							X	PVC where concealed
Within 10' of Chemical Tanks				X							X	PVC where concealed

C. General Purpose Indoor Locations:

1. Electrical Work installed in areas which are not otherwise specifically classified shall be "General Purpose." Workmanship and enclosures shall comply with the general requirements of these Specifications. Electrical power enclosures shall be NEMA Type 1 and electrical control enclosures shall be NEMA Type 12. In these areas exposed conduit shall be galvanized rigid steel conduit (GRC).

D. Outdoor and Damp Locations:

1. In outdoor locations, raceway shall be galvanized rigid steel (GRC) conduit unless otherwise noted; entrances shall be threaded; and fittings shall have gasketed covers. Provisions shall be made to drain the fitting or conduit system. Threaded fastening hardware shall be stainless steel. Raceway supports such as hanger rods, clamps, and brackets shall be galvanized. Attachments or welded assemblies shall be galvanized after fabrication. Instruments and control cabinets, and panel enclosures shall be NEMA Type 4X.

E. Hazardous Locations:

1. All conduit and enclosures installed in hazardous locations to comply with NEC Article 500. All conduit to be PCS. Enclosures to be NEMA rated and listed for environment.

1.11 SEQUENCING:

A. General:

1. Testing requirements for equipment are specified in each section of Division 26 specifications.
2. General scheduling requirements are specified in Section 01 32 16.
3. Work restrictions and other scheduling requirements are specified in Section 01 14 40.

B. Pre-submittal Conferences:

1. Before producing any submittals, schedule a Pre-submittal Conference for the purposes of reviewing the entire project, equipment, control philosophy, schedules, and submittal requirements.
2. The Contractor, Instrumentation and Control System Contractor, Electrical Contractor, and all suppliers furnishing major pieces of equipment must attend, including but not limited to:
    a. Vendor Control Panels.
    b. Chemical Feed Suppliers.
    c. Motor Control Centers.
    d. Switchgear.
    e. Variable Frequency Drive.
    f. Lighting.

C. Factory Acceptance Testing:
1. Where Factory Acceptance Testing is required for equipment covered by these Specifications, notify the Engineer in writing when the equipment is completed and ready for factory inspection and testing;
    a. Indicate the desired dates for inspection and testing.
    b. Furnish notice at least 10 Working days before the date of the test to allow the Engineer and Owner to arrange to attend.

D. Final Review and Notice of Completion:
1. Notify the Engineer in writing that the Work is completed and ready for final review and test:
    a. State the desired dates for the review and testing.
    b. Furnish notice at least 10 Working days before the date of the test to allow the Engineer to arrange to attend.

1.12 WARRANTY

A. Warrant the performance and the hardware of the complete electrical systems including all lamps, lighting, switchgear, circuit breakers, transformers, MCCs. VFD, etc. for a minimum period of 1 year following the date of substantial completion of the Work unless noted otherwise in specific sections. Additionally:
1. To fulfill this obligation, provide technical service personnel designated by the Electrical Contractor and/ or Manufacturer.
2. Perform services to correct any defect within 3 calendar days after notification by the Owner of a defect.

B. Warrant the satisfactory performance of the software, equipment, and materials under the specified operating conditions.
1. If operations, tests, or inspections disclose latent defects or failure to meet the specified requirements, upon notification by the Owner, promptly correct or repair any such defects or non-conformance, or furnish such new equipment or parts as may be necessary for conformity to the specified requirements.

C. Replace or modify equipment, software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements. Following replacement or modifications retest the system and perform additional testing to

place the complete system in satisfactory operation and obtain compliance acceptance from the Engineer.

D. Provide all parts, material, labor, travel, subsistence, or other expenses incurred in providing services and service visits during the warranty period:
   1. Furnish spare parts and tools on site at inventory levels sufficient to meet the response and repair times specified.
      a. All spare parts and tools stored on-site become the property of the Owner upon completion of the warranty period.

1.13 MAINTENANCE

A. Provide similar items of same Manufacturer throughout the Electrical and Instrumentation portion of the project.

B. Furnish all spare parts as required by other sections of the Specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide similar items of same Manufacturer throughout the Electrical and Instrumentation portion of the project.

B. Allowable Manufacturers are specified in individual Specifications in other Sections.

2.2 MATERIALS

A. Furnish all materials under this contract, new, free from defects, and standard products produced by Manufacturers regularly engaged in the production of these products and that bear all approvals and labels as required by the Specifications.

B. Provide materials complying with the applicable industrial standard, except where these specifications are more stringent.

C. Stainless Steel:
   1. Where stainless steel is indicated or used for any portion of the electrical Work, provide a non-magnetic, corrosion-resistant alloy, ANSI Type 316, satin finish.
   2. Provide exposed screws of the same alloys
   3. Provide finished material free of any burrs or sharp edges.
   4. Use only stainless-steel hardware, when chemically compatible, in all areas that are or could be in contact with corrosive chemicals (sulfur dioxide, caustic, fluorides, or others).
   5. Use stainless steel hardware, when chemically compatible, in all areas designated Corrosive and Wet Areas Requiring NEMA 4X Construction.

2.3 EQUIPMENT

A. Provide all equipment that is new, free from defects, and standard products produced by Manufacturers regularly engaged in the productions of these products that bear all approvals and labels as required by the Specifications.

B. Alternative Equipment and Methods:
   1. Equipment or methods requiring redesign of any project details are not acceptable without prior written approval of the Engineer through the "or equal" process as defined in the Specifications.

2.4 SOURCE QUALITY CONTROL

A. Arrange with all Manufacturers of the equipment and fabricators of panels and cabinets, to allow the Owner and Engineer to inspect and witness the testing of the equipment at the site of fabrication:
   1. Testing includes the cabinets, special control systems, power equipment, and other pertinent systems and devices.
   2. Make no shipments without the Engineer's approval.

B. Factory Testing is specified in Divisions 26 and 40.

C. Furnish all equipment listed by and bearing the label of Underwriters' Laboratories, Incorporated (UL) or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Study all Drawings and Specifications and to report to the ENGINEER before bidding:
   1. Any errors.
   2. Any omissions
   3. Any Electrical Code problems
   4. Any Local Building Code problems.
   5. Any points of conflict with other trades.

B. It is the Electrical Contractor's responsibility to be fully familiar with the existing conditions and local requirements and regulations. Difficulties that arise after the Contract has been awarded which could have been avoided by a more complete initial site visit are the responsibility of the Electrical Contractor to correct.

C. Review the existing site conditions and examine all shop drawings for the various items of equipment to determine exact routing and final terminations for al wiring and cables.

D. The Contractor, through the System Supplier, is responsible for the complete electrical and instrumentation Work:

1. Install extra conduits, cables, and interfaces as may be necessary to provide a complete and operating electrical, power, and Process Control and Instrumentation System.

3.2 PREPARATION

A. The construction and installation of all electrical equipment and materials must comply with all applicable provisions of the:
   1. OSHA-Safety and Health Standards
   2. State building standards
   3. Applicable local codes and regulations

B. Furnish, place, and maintain guards, night-lights, protective screens, warning signs, etc. as required to prevent accidents or injuries to all personnel.

3.3 INSTALLATION

A. Equipment locations shown on Electrical Drawings may change due to variations in equipment size or minor changes made by others during construction:
   1. Verify all dimensions indicated on the Drawings:
      a. Actual field conditions govern all final installed locations, distances, and levels.
   2. Review all information shown on the Contract Drawings, including architectural, structural, mechanical, instrumentation, and the accepted electrical and mechanical shop drawings, and coordinate Work as necessary to adjust to all conditions that arise due to such changes.

B. Cutting and patching:
   1. Perform all cutting, patching, channeling, core drilling, and fitting required for the Electrical Work, except as otherwise directed:
      a. Actual field conditions govern all final installed locations, distances, and levels.
         1) Before cutting, channeling, or core drilling any surface, ensure that no penetration of any other systems will be made.
            a) Verify that area is clear and free of conduits, cables, piping, ductwork, post-tensioning cables etc.
            b) Use tone-locate system or X-ray to ensure that area is clear of obstructions.
         2) Review the complete Drawing set to ensure that there are not conflicts or coordination problems before cutting, channeling, or core drilling any surface.
   2. Perform all patching to the same quality and appearance as the original Work. Employ the proper tradesmen to secure the desired results. Seal around all conduits, wires, and cables penetrating walls, ceilings, and floors in all locations with a fire stop material, typically:

a.	3M	CP25	Caulk
b.	3M	303	Putty
c.	T&B	S-100	Caulk
d.	T&B	FS-500	Putty

e. T&B FST-60l Putty

3. Seal around conduit penetrations of below grade walls with a waterproof, non-shrink, nonmetallic grout:
   a. Use the Installation Details provided in the Contract Drawings as a guide for acceptable sealing methods.

C. Install all conduit and equipment in such a manner as to avoid all obstructions and to preserve headroom and keep openings and passageways clear:
   1. Install all conduits and equipment in accordance with Working space requirements as outlined in Article 110, Requirements for Electrical Installation of the National Electrical Code.

D. Earthwork and Concrete:
   1. Install all trenching, shoring, concrete, backfilling, grading and resurfacing associated with the electrical work.
   2. Notify the Engineer before encasing or backfilling any electrical work, and arrange for inspection.

E. Roof Penetrations:
   1. Make all roof penetrations, and seal around all conduits. Use pitch pockets and flashings.
   2. Roofing Contractor to make actual seals around roof penetrations.

F. Terminations:
   1. Terminate all conductors required to interconnect power, controls, instruments, panels and other equipment otherwise specifically identified.

G. Miscellaneous Installation Requirements:
   1. In case of interference between electrical equipment shown on the Drawings and the other equipment, notify the Engineer in writing of the proposed change:
      a. Obtain Engineer's acceptance of the proposed changes before they are made.
   2. Location of manholes and pullboxes shown on Drawings are approximate. Coordinate exact location of manholes and pullboxes with mechanical and civil Work.
   3. Provide additional manholes or pullboxes to those shown where they are required to make a Workable installation.
   4. Circuits of different service voltage:
      a. Install in separate raceways, hand holes, pullboxes, and junction boxes.
      b. In manholes, install all cables operating at less than 50 VDC PVC coated flexible metallic conduit.
      c. The voltage and service levels are:
         1) Medium voltage: 12.47 KV
         2) Low voltage: 120 V, 208 V, 480 V
         3) Control: less than 50 VDC

H. Labeling:
   1. Provide all nameplates and labels as required in specification Section 26 05 53.

I. Equipment Tie-Downs:

1. Anchor all instruments, control panels, and equipment by methods that comply with seismic and wind bracing requirements, which apply to the site. See seismic design criteria, Section 01 81 10.
2. All control panels, VCPs, LCPs, RTUs, PCMs, etc., must be permanently mounted and tied down to structures in accordance with requirements, which apply to the site.

3.4 FIELD QUALITY CONTROL

A. Inspection:
1. Conduct inspection of electrical, instrumentation and control system installation in accordance with provisions outlined in Section 01 41 26 of the General Requirements.
2. Allow Owner, Engineer, or Owner's Representative access to site for inspection of materials, equipment, or installation at any time.
3. Provide any technical data or other assistance necessary to support inspection activities.
4. Electrical inspections include, but not limited to, the following:
    a. Inspect equipment and materials for physical damage.
    b. Inspect installation of compliance with plans and specifications
    c. Inspect installation for obstructions and adequate clearances around equipment.
    d. Inspect equipment installation for proper leveling, alignment, anchorage and assembly.
    e. Inspect equipment nameplate data to verify compliance with design requirements.
    f. Inspect raceway installation quality Workmanship and adequate support.
    g. Inspect cable terminations.
    h. Schedule Structural Engineer to inspect all mounting of electrical devices and all penetrations and connections to structures.
5. Inspection activities conducted during construction do not satisfy inspection requirements outlined in each section of the Division 26 specifications.

B. Testing:
1. When the electrical Work is substantially completed, notify the Engineer that the project is ready for Field Acceptance Testing.
2. Perform the acceptance test in conformance with each section of the Division 26 specifications.
3. Record results of the required tests along with the date of test:
    a. Use conduit schedule identification numbers to indicate portion of circuit tested.

C. Workmanship:
1. Use only competent and skilled personnel experiences in their trade, Working under continuous competent supervision, to perform all Work, including installation, connection, calibration, testing, and adjustment.
    a. Perform all Work, including aesthetic as well as electrical and mechanical aspects, to standards consistent with the best practices of the trade.
2. All Work is subject to review by the Engineer or Owner at any time.
3. Provide all Work to the complete satisfaction of the Engineer or Owner.

4. Repair or replace any Work, which, in the sole opinion of the Engineer, does not conform to these Specifications, or trade practices.
5. Make all changes of any installed items to meet the intent of the Drawings and Specifications.
6. Install all materials and equipment in accordance with the Manufacturer's printed installation instructions.
    a. Where Contractor asks to deviate from the Manufacturer's recommendations, such changes shall be reviewed by the Engineer and Manufacturer before installation.

3.5 CLEANING

A. General Requirements:
1. Maintain all surfaces to be painted in a clean and smooth condition.
2. Remove all foreign material and restore all damaged finishes to the satisfaction of the Engineer and Owner.
3. Remove all debris, rubbish, and scraps, etc. each night.
4. Leave all areas swept clean each night.
5. Wipe clean all exposed threads of conduit of the KOPR-SHIELD compound after installation.

B. Vacuum clean all electrical enclosures of any debris before any wire or cable is installed.

C. Clean and re-lamp all new and luminaries that were used in the area affected by the construction, and return all used lamps to Owner.

D. As specified in other Sections of the Specifications.

E. Leave wiring in panels, manholes, boxes, and other locations neat, clean, and organized:
1. Neatly coil and label spare wiring lengths.
2. Shorten re-terminate, and re-label excessive spare wire and cable lengths, as determined by the Engineer.

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. 600 V Class wire and cable.
2. Instrumentation Class wire and cable.
3. Network cable.
4. 600 V Class Tray cable.

B. Related Sections - Contract Documents are a single integrated document, and as such all divisions and sections apply. It is the responsibility of the Contractor and its Sub-contractors to review all sections to ensure a complete and coordinated project.

1.2 REFERENCES:

A. American Society for Testing and Materials (ASTM):
1. B3 – Standard Specification for Soft or Annealed Copper Wire.
2. B8 – Specification for Concentric-Lay Copper Conductors, Hard, Medium-Hard, or Soft.

B. Insulated Cable Engineers Association (ICEA):
1. IPCEA X-61-402 for thermoplastic insulated wire and cable for the transmission and distribution of electrical energy.
2. IPCEA S-61-402 for rubber insulated wire and cable for the transmission and distribution of electrical energy.

C. National Electrical Code (NEC):
1. Article 250 – Grounding.
2. Article 310 – Conductors for General Wiring.
3. Article 760 – Fire Alarm Systems.

D. National Fire Protection Association (NFPA):
1. Article 72 – National Fire Alarm Code.
2. Article 101 – Life Safety Code.
3. Article 262 – Standard Method of Test for Flame Travel and Smoke or Wires and Cables for Use in Air-Handling Spaces.

E. Federal Specification J-C 30A.

F. Underwriters Laboratories (UL):
1. UL 1277 – Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
2. UL 1063 – Machine-Tool Wires and Cables.
3. UL 1581 – Reference Standard for Electrical Wires, Cables, and Flexible Cords.
4. UL 2196 – Tests for Fire Resistive Cables.

5. UL 1424 – Cables for Power-Limited Fire-Alarm Circuits.
6. UL 1569 – Metal-Clad Cables.
7. UL 225 – Metal-Clad Cables and Cable-Sealing Fittings for Use in Hazardous (Classified) Locations.

G. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
1. TAI/EIA/TSB95 – Additional Transmission Performance Guidelines for 4-pair 100 W Category 5 Cabling.
2. TIA/EIA-568-A Additional Transmission Performance Specifications for 4-pair 100 W Enhanced Category 5 Cabling.
3. TSB72 - Centralized Optical Fiber Cabling Guidelines, October 1995.

1.3 DEFINITIONS

A. Definitions of terms specified in Division 26, Section 26 00 00 "Electrical General Provisions."

B. Definitions of terms and other electrical considerations as set forth in the:
1. NEC: National Electrical Code.
2. IEEE: Institute of Electrical and Electronic Engineers.
3. ICEA: Insulated Cable Engineering Association.
4. NFPA: National Fire Protection Association.
5. ASTM: American Society of Testing Materials.

1.4 SYSTEM DESCRIPTION

A. Furnish and install the complete wire can cable system.

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Section 26 00 00.

B. Product Data:
1. Manufacturer of Wire and Cable.
2. Insulation:
   a. Type.
   b. Voltage class.
3. American Wire Gauge Size.
4. Conductor material.
5. Pulling compounds.

C. Shop Drawings:
1. Show splice locations.

D. Calculations:
1. Submit cable pulling calculations for all conductor sizes for pulling lengths longer than 1,000 feet.

E. Test Reports:
   1. Submit test reports for megohm tests.

1.6 QUALITY ASSURANCE

A. As specified in Section 26 00 00 and as noted below.

B. Furnish and install all wire and cable in conformance with the applicable standards.

C. All wires and cables shall be UL listed and labeled.

1.7 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26 00 00 and as noted below.

B. Provide new wires and cables manufactured within 1 year of the date of delivery to the site.

C. Delivery conductors to the site in their original unbroken packages or on their original cable reels.

D. Store conductors out of the weather and where not subject to physical or chemical damage.

1.8 WARRANTY

A. As specified in Section 26 00 00 and as noted below.

B. Provide a complete material and installation warranty for all wires and cables, for a period of 2 years from substantial completion.
   1. During the warranty period, replace any wire or cable found to be defective along with all other wires and cables in the raceway containing the defective wire or cable.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. One of the following or Engineer approved equal:
   1. 600 V Class wire and cable:
      a. General Cable.
      b. Okonite Company.
      c. Rome Cable Corporation.
      d. Southwire Company.
   2. Instrumentation Class wire and cable:
      a. Alpha Wire Company.
      b. Belden.
      c. General Cable BICC Brand.
      d. Okonite Company.
      e. Rockbestos Surprenant Cable Corporation.
      f. Rome Cable Corporation.
   3. Network Cables:
      a. Belden.

b. General Cables.
c. Lucent.

4. Fiber optic cables.
   a. Belden.
   b. General Cables.
   c. Lucent.

2.2 MATERIALS

A. Conductors:
   1. Copper per ASTM B3.
   2. Minimum 97% conductivity.

2.3 MANUFACTURED UNITS

A. General:
   1. Permanently mark each wire and cable with the following at 24-inch intervals.
      a. American Wire Gauge (AWG) size.
      b. Voltage rating.
      c. Insulation type.
      d. UL symbol.
      e. Month and year of manufacture.
      f. Manufacturer's name.
   2. Identify and mark wire and cable as specified in Section 26 05 53:
      a. Use integral color insulation for Number 2 AWG and smaller wire.
      b. Wrap colored tape around cable larger than Number 2 AWG.

B. 600 V Class wire and cable:
   1. Provide American Wire Gauge (AWG) or kcmil sizes as indicated on the drawings or in the conduit schedules:
      a. When not indicated on the drawings, size wire as follows:
         1) In accordance with the National Electrical Code:
            a) Use 75°C ampacity ratings.
            b) Ampacity rating after all derating factors, equal to or greater than rating of the overcurrent device.
         2) Provide Number 12 AWG minimum for power conductors.
         3) Provide Number 14 AWG minimum for control conductors.
   2. Provide Class B standing per ASTM B8:
      a. Provide Class C stranding where extra flexibility is required.
   3. Insulation:
      a. THWN/THWN-2.
      b. 75°C/90°C rating in wet or dry locations, respectively.
   4. Multi-conductor Cables:
      a. Number and size of conductors, as indicated on the drawings or in the conduit schedules.
      b. Individual conductors with THWN/THWN-2 insulation.
      c. Overall PVC jacket.
      d. Tray Cable rated.

e. Color coding for control wire per ICEA Method 1, E-2.
f. Ground conductor: Insulated, green, and sized per NEC 250-122.

C. Instrumentation class cable:
1. Type TC.
2. Suitable for use in wet locations.
3. Voltage Rating: 600 V.
4. Temperature Rating: 90° C wet or dry location.
5. Conductors:
a. Insulation:
1) Flame-retardant PVC, 15 mils nominal thickness, with nylon jacket 4 mils nominal thickness.
b. Number 16 AWG stranded and tinned.
c. Color Code:
1) Pair: Black and white.
2) Triad: Black, white and red.
3) Multiple pairs or triads: Color-coded and numbered.
6. Drain Wire:
a. 18 AWG.
b. Stranded, tinned.
7. Jacket:
a. Flame retardant, moisture and sunlight resistant PVC.
b. Rip-cord laid longitudinally under jacket to facilitate removal.
8. Shielding:
a. Individual pair-triad:
1) Minimum 1.35-mil double-faced aluminum foil-polyester tape overlapped to provide 100 percent coverage.
b. Multiple Pair or Triad Shielding:
1) Group Shield: Minimum 1.35-mil double-faced aluminum foil/polyester tape overlapped to provide 100 percent coverage.
2) Completely isolate group shields from each other.
3) Cable Shield: 2.35 miles double-faced aluminum and synthetic polymer backed tape overlapped to provide 100 percent coverage.
c. All shielding to be in contact with the drain wire.

D. Network cables:
1. Category 6:
a. Conductors:
1) 23 AWG solid bare annealed copper.
b. Insulation:
1) Polyolefin.
2) 4 twisted pairs.
c. Color code:
1) Blue-Blue/White.
2) Orange-Orange/White.
3) Green-Green/White.
4) Brown-Brown/White.
d. Outer jacket:
1) PVC with ripcord.

e. Electrical characteristics:
    1) Frequency range: 1-600 MHz.
    2) Attenuation: 51.4 dB.
    3) Power sum NEXT: 32.6 dB.
    4) Attenuation to Crosstalk ratio: 0.0 dB.
    5) Equal Level Far-End Crosstalk (ELFEXT): 15.2 dB.
    6) Power-sum ELFEXT: 15.2 dB.
    7) Return loss: 17.6 dB.
    8) Propagation delay: 548 nanoseconds.
    9) Delay skew: 50 nanoseconds.

2. RS-485 Cable:
    a. 2-wire:
        1) Shielded twisted pair.
        2) Tinned, copper conductors minimum with 7 by 30 stranding.
        3) AWG #22.
        4) Insulation:
            a) FHDPE – foam high density polyethylene.
            b) 300 V insulation level.
        5) Outer shield:
            a) 100 percent coverage.
            b) Tape/Braid.
            c) Aluminum foil polyester tape.
            d) Tinned copper braid.
        6) Outer shield drain wire:
            a) Tinned, copper conductor minimum with 7 by 30 stranding.
            b) AWG #22
        7) Outer Jacket PVC (polyvinyl chloride):
            a) Sunlight resistant.
        8) UL/CSA flame tested.
        9) Minimum bending radius of 3.6 inches.
        10) Nominal OD of 0.356 inches.

E. Fiber optic cable:
1. All optical fiber cable used shall have the following physical characteristics:
    a. OM1 12 strand
    b. Cable Core:
        1) Building interior: Air core
        2) Building exterior: Filled core stable from -40F to +140F

    c. Cable Composition:
        1) Building Interior:
            a) Station:
                i. (plenum) - OFNP Flouropolymer jacket.
                ii. (non-plenum) - OFNR PVC jacket.
            b) Riser - OFNR PVC jacket.
        2) Building exterior: Non-metallic dielectric
    d. Cable Strength: Maximum pulling tension of 600 lbs.
    e. Minimum Bend Radius:
        1) (<30% max. pull tension) 10 times cable diameter.

2) (>30% max. pull tension) 20 times cable diameter.

f. Fiber Identification: Color coding system adequate to unambiguously identify each fiber. The words "Fiber Optic Cables" shall be imprinted on cable no more than three (3) feet apart.

2.4 ACCESSORIES

A. Wire Ties:
1. One of the following or equal:
a. T&B "Ty-Rap" cable ties.
b. Panduit cable ties.

2.5 SOURCE QUALITY CONTROL

A. Assembly and testing of cable shall comply with the applicable requirements of ICEA publication No. S-68-516.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Color Coding:
1. Color coding shall be consistent throughout the facility.
2. The following color code shall be followed for all 240/120 V and 208/120 V systems:
a. Phase A – Black.
b. Phase B – Red.
c. Phase C – Blue.
d. Single-Phase System – Black for one hot leg, red for the other.
e. Neutral – White.
f. Equipment Ground – Green.
3. The following color code shall be followed for all 480/277 V systems:
a. Phase A – Brown.
b. Phase B – Orange.
c. Phase C – Yellow.
d. Neutral – Gray or White.
e. Equipment Ground – Green.
4. The following color code shall be followed for all 120 VAC control wiring:
a. Power – Red.
b. Neutral – White.
5. The following color code shall be followed for all general purpose DC control circuits:
a. Negative – Grey.
b. Positive – Violet.
6. Switch legs shall be blue. Three-way switch runners shall be violet.
7. Wires in intrinsically safe circuits shall be light blue.
8. Wire colors shall be implemented in the following methods:
a. Wires manufactured of the designed color.

B. Install conductors only after the conduit installation is complete, all enclosures have been vacuumed clean, and the affected conduits have been swabbed clean and dry.

1. Install wires only in approved raceways.
2. Do not install wire:
    a. In incomplete conduit runs..
    b. Until after the concrete work and plastering is completed.

C. Properly coat wires and cables with pulling compound before pulling into conduits and prevent mechanical damage to conductors during installation:
    1. For all Number 4 AWG and larger, use an approved wire-pulling lubricant while cable is being installed in conduit:
        a. Ideal products.
        b. Polywater products.
        c. 3M Products.
        d. Greenlee products.
        e. Or equal as recommended by cable manufacturer.
        f. Do not use oil, grease, or similar substances.

D. Cable pulling:
    1. For cables Number 1 AWG and smaller, install cables by hand.
    2. For cables larger than Number 1 AWG, power pulling winches may be used if they have cable tension monitoring equipment.
    3. Provide documentation that maximum installed cable tension is no more than 75 percent of the maximum recommended level as published by the cable manufacturer. If exceeded, the Engineer may, at his discretion, require replacement of the cable.
    4. Where approved by the Engineer, make splices where cable pulling tension or sidewall pressure exceeds manufacturer recommendation for the specified cable size:
        a. Make splices in manholes or pull boxes only.
        b. Leave sufficient slack to make proper connections.

E. Use smooth-rolling sheaves and rollers when pulling cable into cable tray to keep pulling tension and bending radius within manufacturer's recommendations.

F. Install and terminate all wire in accordance with manufacturer's recommendations.

G. Neatly arrange and lace conductors in all switchboards, panelboards, pull boxes, and terminal cabinets by means of wire tires:
    1. Do not lace wires in gutter or panel channel.
    2. Install all wire ties with a flush cutting wire tie installation tool:
        a. Use a tool with an adjustable tension setting.
    3. Do not leave sharp edges on wire ties.

H. Terminate solid conductors at equipment terminal screws with conductor tightly wound around the screw so that it does not protrude beyond the screw head:
    1. Wrap the conductor clockwise so that the wire loop is closed as the loop is tightened.
    2. Do not use crimp lugs on solid wire.

I. Terminate stranded conductors on equipment box lugs such that all conductor strands are confined within the lug:
    1. Use ring type lugs if box lugs are not available on the equipment.

J. Provide continuous circuits from origin to termination whenever possible, except for Number 10 AWG and smaller conductors in lighting and receptacle circuits.

K. Splices:
1. Except for Number 10 AWG and smaller conductors in lighting and receptacle circuits.
2. Where splices are necessary because of extremely long wire or cable lengths that exceed standard manufactured lengths, make said splices in labeled junction boxes for power conductor or termination cabinets for control and instrument conductors.
3. Power and control conductors routed in common raceways may be spliced in common junction boxes.
4. Install NEMA 4X junction and terminal boxes in wet and outdoor locations. Clearly label junction and terminal boxes containing splices with the word "SPLICE".
5. Leave sufficient slack at junction boxes and termination boxes to make proper splices and connections. Do not pull splices into conduits.
6. Install splices with compression type butt splices and insulate using a heat-shrink sleeve:
    a. In wet areas, provide heat-shrink sleeves that are listed for submersible applications.
    b. Splices in below grade pull boxes, in any box subject to flooding, and in wet areas shall be made watertight using heat-shrink sleeves that are listed for submersible.

L. Terminations (600 V or Less):
1. Terminate control and instrument conductors on terminal boards with set-screw pressure connectors, with spade or ring lug connectors.

M. Apply wire markers to all wires at each end after being installed in the conduit and before meg-ohm testing and termination.

N. Do not use common neutrals for any lighting circuits or receptacle circuits:
1. Use a separate neutral for each phase circuit.

O. Instrumentation Class Cable:
1. Install instrumentation class cables in separate raceway systems from power cables:
    a. Install instrument cable in metallic conduit within non-dedicated manholes or pull boxes.
    b. Install cable without splices between instruments or between field devices and instrument enclosures or panels.
2. Do not make intermediate terminations, except in designated terminal boxes as indicated on the drawings.
3. Ground cable shields at only one location, not at field instruments.

P. Multi-Conductor Cable:
1. Where cable is not routed in conduit with a separate ground conductor, use one conductor in the cable as a ground conductor:
    a. Use an internal ground conductor, if it is no smaller than as indicated on the drawings and meets NEC requirements for equipment ground conductor size.
    b. Where two parallel cables are used, and the internal ground conductor in each cable does not meet NEC requirements for the combined circuit, use 4-conductor cable, with one of the full-sized conductors serving as ground.

Q. LAN Cable Testing:
1. Testing scope: Test all installed LAN cables.
2. Test plan and witnessing: Obtain Engineer's approval for the test procedures as part of the submittal process. Arrange for the Engineer to witness all testing. Submit a request for witness 15 days (minimum) before the proposed test date.
3. Pre-testing:
    a. Test individual cables before installation.
        1) Before physical placement of the cable, the installer shall test each cable while on the spool with a LAN certification test device.
        2) Before the cable is installed, the installer shall check that the cable conforms to the manufacturer's attenuation specification and that no damage has been done to the cable during shipping or handling.
        3) The test shall be fully documented, and the results submitted to the Engineer, including a hard copy of all the traces, before placement of the cable.
        4) The Engineer shall be notified if a cable fails to meet specification and the cable shall not be installed unless otherwise directed by the Engineer.
4. Test Equipment:
    a. LAN certification equipment used for the testing shall be capable of testing Category 6 cable installation to TIA proposed Level III accuracy. Tests performed shall include:
        1) Near End Cross Talk
        2) Attenuation
        3) Equal Level Far End Cross Talk
        4) Return Loss
        5) Ambient Noise
        6) Effective Cable length
        7) Propagation Delay
        8) Continuity/Loop Resistance
    b. LAN certification test equipment shall be able to store and produce plots of the test results.
    c. Manufacturers – One of the following:
        1) Agilent Technologies, WireScope 350.
        2) Or approved equal.

R. Signal cable:
1. Separate and isolate electrical signal cables from sources of electrical noise and power cables by a minimum of 12 inches.

S. Submersible cable in wet wells:
1. Provide Kellem's grip or stainless steel wire mesh to support cable weight and avoid stress on insulation.

T. Wiring Allowances:
1. Equipment locations may vary slightly from the drawings. Include an allowance for necessary conductor and terminations for motorized equipment, electrical outlets, fixtures, communication outlets, instruments, and devices within 10 linear feet of locations indicated on the drawings.

2. Locations for pull boxes, manholes, and duct banks may vary slightly from the drawings. Include an allowance for necessary conductors and related materials to provide conductors to all pull boxes, manholes, and duct banks within 20 linear feet of locations indicated on the drawings.

3.2 FIELD QUALITY CONTROL

A. Testing: As specified in Section 26 08 00 "Field Electrical Acceptance Tests."

B. Grounding: As specified in Section 26 05 26 "Grounding and Bonding."

END OF SECTION

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SECTION 26 05 26
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

A. ASTM International.

B. Code of Federal Regulations.

C. Institute of Electrical and Electronics Engineers, Inc.

D. InterNational Electrical Testing Association, NETA.

E. NFPA 70, National Electrical Code.

F. Underwriters Laboratories Inc.

1.3 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment**.**

B. Related Sections include the following:
   1. Division 26 Section 26 00 00 “Electrical General Provisions”.

1.4 SUBMITTALS

A. Furnish complete submittals in accordance with Section 26 00 00.

B. Product Data: For each type of product indicated.

C. Other Informational Submittals: Plans showing dimensioned as-built locations of test wells.

D. Qualification Data:
   1. Submit a written resume for the individual who will perform the grounding tests detailing experience and qualifications.
   2. Submit detailed information concerning test instruments, and tester’s qualifications to perform the specified tests.

E. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Perform work to meet the requirements of legally constituted authorities having jurisdiction. Comply with the latest editions, amendments, practices, and rulings of the following documents and organizations, except where these specifications and the drawings are more stringent:
   1. American National Standards Institute.
   2. National Electrical Code, Article 250.
   3. Local and State Codes.
   4. IEEE 81.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V, unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.
   3. Grounding Electrode Conductor: Conductor shall be sized in accordance with the National Electrical Code article 250.66, except where these specifications or the drawings are more stringent.
   4. Bonding Conductors and Bonding Jumpers: Shall be sized in accordance with the National Electrical Code article 250, except where these specifications or the drawings are more stringent.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory, acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Compression Connectors:
   1. Made of high copper alloy and manufactured specifically for the particular grounding application.
   2. Suitable for direct burial in earth and concrete.
   3. Identifying compression die number inscription to be impressed on compression fitting.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 5/8 inch in diameter by 8 feet in length.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Bare Copper Conductors: Install solid conductor for, No. 6 and 8 AWG, and stranded conductors for, No. 4 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum or as indicated on the drawings.
   1. Bury at least 30 inches below grade.
   2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.
   4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than six (6) inches from the foundation.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.

3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
8. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

F. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor, in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least three (3) rods spaced at least one-rod length from each other, and located at least the same distance from other grounding electrodes. Connect to the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from the equipment shutoff valve.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

G. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building. Bury ground ring not less than 30 inches below the earth’s surface.
1. Install copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches from building foundation.

H. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four (4) locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.5 FIELD QUALITY CONTROL

A. Qualified individual shall perform the following tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
    a. Measure ground resistance not less than two (2) full days after last trace of precipitation, without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.
3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity Greater Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 and 3 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

A. American National Standards Institute.

B. ASTM International.

C. Institute of Electrical and Electronic Engineers.

D. National Electrical Manufacturers Association.

E. NFPA 70, National Electrical Code.

F. Underwriters Laboratories Inc.

1.3 SUMMARY

A. This Section Includes:
   1. Outlet boxes and covers.
   2. Conduit bodies.

B. Related Sections include the following:
   1. Division 26, Section 26 00 00 "Electrical General Provisions".
   2. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.4 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. Institute of Electrical and Electronic Engineers.
   2. National Fire Protection Association.
      a. NFPA 70, National Electrical Code.

1.5 SYSTEM DESCRIPTION

A. Provide outlet boxes for all devices such as switches, receptacles, telephones, computer terminals, security systems etc. Materials shall be suitable for environmental conditions at the location of the box.
   1. Dry.

2. Wet.
3. Water -tight.
4. Corrosive.

B. Locate outlet boxes as indicated on the drawings. Adjust locations so as not to conflict with structural requirements or other trades.

C. All spare and/or empty conduits must terminate in an outlet box.

D. Provide conduit bodies as shown on the plans or as needed to complete the conduit installation.

E. Provide conduit bodies as needed to facilitate wire pulling, or whenever the total amount of bends in a conduit run exceeds 270°, as specified in Section 26 05 34 "Conduits."

1.6 SUBMITTALS

A. Furnish complete submittals in accordance with:
1. Division 26, Section 26 00 00 "Electrical General Provisions."

B. Product Data:
1. Furnish complete manufacturer's catalog sheets for each product used on this project.
2. Furnish complete manufacturer's recommended special tools to be used for installation if required.

C. As-built Drawings:
1. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control test reports.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Regulatory Requirements
1. Outlet boxes must comply with all applicable standards of the:
a. National Electrical Code, NFPA 70.
b. National Electrical Manufacturers Association.
c. Underwriters Laboratories.
d. Joint Industry Conference.

C. Codes and Standards

1. Cast metal boxes.
    a. UL Standard 498 and 514.
    b. Federal Specification No. W-C-586B.
2. Malleable iron boxes.
    a. ASTM A47-77, Grade 32510

PART 2 - PRODUCTS

2.1 CONDUIT BODIES, BOXES, ENCLOSURES, AND CABINETS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
1. Metal Boxes:
    a. Cooper Crouse-Hinds; Division of Cooper Industries, Inc.
    b. EGS/Appleton Electric.
    c. Hoffman.
    d. Thomas & Betts Corporation.
2. Plastic and/or fiberglass boxes:
    a. Hoffman.
    b. Carlon.
3. Plastic coated steel boxes:
    a. Robroy Industries, Inc.; Enclosure Division.
    b. OCAL – Blue, Thomas & Betts Corporation.
4. Cast device boxes:
    a. Cooper Crouse-Hinds; Division of Cooper Industries, Inc.
    b. EGS/Appleton Electric.

B. Pressed Steel Boxes
1. 1-piece galvanized pressed steel.
2. Knockout type boxes.
3. Minimum size 4" square by 2-1/8" deep.
4. In dry heated areas requiring NEMA 1 enclosures, unless otherwise indicated or required.
5. Solid type gang boxes:
    a. For more than 2 devices.
    b. For barriered outlets.

C. Concrete Boxes
1. For outlets in concrete construction.
2. Pressed steel construction, concrete tight.
3. Knockout size ranges from 1/2" to 1".
4. Depth as needed.
5. Types:
    a. 4" octagon.
    b. 4" octagon ceiling boxes with hanging bars.
    c. Gangable masonry boxes:
        1) 3-1/2" deep, 3-3/4" high, length as required.

a) 2-1/2" deep boxes may be used where wall thickness precludes the use of the deeper boxes.

2) With partitions as needed.

D. Threaded-Hub Boxes

1. Use deep threaded-hub malleable iron or aluminum boxes:
   a. Where legally required.
   b. Where exposed to the weather.
   c. In unheated areas.
   d. Where subject to mechanical injury.
      1) Here defined as exposed boxes less than 10 (ten) feet above the floor in areas accessible to anyone other than authorized operating or maintenance personnel.
   e. To act as a pull box for conductors in a conduit system.
   f. Accommodate wiring devices.
2. Cast conduit fittings may be used instead of boxes, except where boxes contain devices.
3. Construction:
   a. Each box shall contain an internal green ground screw.
   b. Each box shall be furnished with a suitable gasketed cover.
   c. Use integral cast mounting lugs when surface mounted.
   d. Conduit size ranges from 1/2" to 1".
   e. Tapered threaded hubs with integral bushing.
4. Aluminum boxes shall be high-strength, copper-free 4/10 of 1% max. alloy use with aluminum rigid conduit.

E. Plastic Coated Threaded-Hub Boxes

1. Use deep threaded-hub plastic coated malleable iron boxes in corrosive areas and NEMA 4X installations, or when the conduit system is type PCS.
   a. Where legally required.
   b. Where exposed to the weather.
   c. In unheated areas.
   d. Where subject to mechanical injury.
      1) Here defined as exposed boxes less than 10 (ten) feet above the floor in areas accessible to anyone other than authorized operating or maintenance personnel.
   e. To act as a pull box for conductors in a conduit system.
   f. Accommodate wiring devices.
   g. Tapered threaded hubs with integral bushing.
2. Cast conduit fittings may be used instead of boxes, except where boxes contain devices.
3. Construction:
   a. Each box shall contain an internal green ground screw.
   b. Each box shall be furnished with a suitable gasketed cover.
   c. With integral cast mounting lugs when surface mounted.
   d. Conduit size ranges from 1/2" to 1".
   e. Double-coated, with a nominal 0.002" (2 mil) urethane on both the interior and exterior prior to application of PVC coating.
   f. With a minimum 0.040" (40 mil) PVC coating bonded to exterior.

g. With pressure sealing sleeve to protect the connection with conduit.

F. Conduit Bodies
1. Material consistent with conduit type:
   a. Cast iron bodies and covers with type GRC.
   b. Cast aluminum bodies and covers with type RAC.
   c. PVC bodies with PVC conduit.
   d. PVC coated cast iron bodies and covers with type PCS.
   e. Cast iron or aluminum bodies with pressed steel or aluminum covers with EMT conduit.
2. Mogul design conforming to NEC requirements for bending space required by 1" and larger conduit, with conductors #4 AWG and larger, or where required for wire bending space.
3. Gasketed covers attached to bodies with stainless steel screws secured to threaded holes in conduit body.
4. PVC coated cast iron conduit bodies and covers:
   a. Bodies prior to coating shall meet requirements for cast iron conduit bodies.
   b. 0.040-inch exterior PVC coating and 0.002-inch interior urethane coating, as required for type PCS conduit and fittings.
   c. Utilize the PVC coating as an integral part of the gasket design.
   d. Stainless steel cover screw heads shall be encapsulated with plastic to assure corrosion protection.
   e. As manufactured by:
      1) Robroy REDH2OT, form 8 and mogul.
      2) OCAL Blue, form 8 and mogul.
5. PVC conduit bodies and covers as manufactured by Carlon.
6. Cast iron and cast aluminum bodies and covers as manufactured by:
   a. Appleton FM8 and mogul.
   b. Crouse-Hinds form 8 and mogul.

G. PVC Molded Junction Boxes
1. Boxes such as FSE, FSC, FSS, FSCC, etc. will be allowed, and compression type splices may only be made in these enclosures:
   a. Integral mounting feet for surface mounting.
   b. Molded plastic hubs for solvent welded conduit terminations.
   c. Conduit range 1/2" to 1".
   d. With gasketed covers and stainless steel attachment screws.
   e. As manufactured by:
      1) Carlon.
      2) P W Pipe.
2. PVC molded conduit bodies such as T, LL, LR, LB, C, E, X, etc. will be allowed; however, no splices may be made in these conduit bodies.
   a. Molded plastic hubs for solvent welded conduit terminations.
   b. Conduit range 1/2" to 2".
      1) Type LB up to 4".
3. With gasketed covers and stainless steel attachment screws.
4. As manufactured by:
   a. Carlon.
   b. P W Pipe.

H. Fiberglass Boxes
1. NEMA 4X, watertight, dust tight, corrosion-resistant, use only with PVC conduit.
2. Constructed of molded fiberglass reinforced polyester.
3. Integral neoprene gasket on cover attached with an oil- resistant adhesive.
4. Enclosures to have internal pads for mounting optional panels and terminal kits.
5. Covers:
   a. Screw cover enclosures.
      1) Covers held in place with captive, stainless steel or monel screws.
      2) Covers attached to body with internal zinc-plated steel hinges.
   b. Quick release latch covers.
      1) Corrosion resistant fiberglass hinges.
      2) Spring-loaded fiberglass latches with a monel or stainless steel bail attached with monel or stainless steel screws.
      3) With a 316 stainless steel padlock hasp.
6. External mounting feet.
7. Meeting the following minimum standards and tests:

Physical Property	Value	ASTM Method
Flexural Strength	12,000 psi	D-790
Heat Distortion	400°F	D-648
Water Absorption (24 hours)	0.5%	D-570
Tensile Strength	5000 psi	D-651
Specific Gravity	1.8	D-792
Flammability	94V-0	UL-94
Dielectric Strength	400 V.P.M.	D-149
Arc Resistance	180 Sec	D-495

8. All boxes to be supported with a minimum of 0.25” air space between the enclosure and supporting surface.
9. As manufactured by:
   a. Hoffman Engineering, TYPE JFG.
   b. Stahlin, TYPE CL.

I. Formed Steel Enclosures Usage Designed to house electrical controls, terminals, and any other devices.
1. Steel:
   a. NEMA 12.
   b. Fabricated from 14-gauge steel.
   c. All seams continuously welded ground smooth.
   d. Door shall have a rolled lip around three (3) sides.
      1) Attached to enclosure by means of a continuous stainless steel hinge and pin.
   e. Neoprene door gasket to provide a watertight seal:
      1) Attached with an adhesive.
      2) Retained by a retaining strip.
   f. All external removable hardware shall be fabricated from heavy gauge steel and shall be zinc plated, which shall clamp the door to the enclosure body.
   g. With a hasp and staple for padlocking.
   h. With a removable print pocket.

i. Internal panels:
   1) With plated steel shoulder studs for mounting an internal panel.
   2) Mounting panels shall be steel.
j. Large enclosures shall have door and body stiffeners for extra rigidity.
k. With no holes or knockouts.
l. Finish shall be:
   1) ANSI-61, gray electrostatically-applied polyester powder inside and out over phosphatized surfaces.
   2) White electrostatically-applied polyester powder mounting plate.
m. Heavy gauge steel external mounting brackets when surface mounted.
n. Floor stand kit when shown:
   1) Fabricated from 12-gauge steel.
   2) Bottom plate 11-gauge.
   3) Heights:
      a) 6".
      b) 12".
      c) 18".
      d) 24".
   4) When a floor stand kit is used, the box shall not have any external mounting brackets.
o. As manufactured by:
   1) Hoffman.
   2) Thomas & Betts.
   3) Stahlin.
   4) Rittal.

2. Stainless Steel:
a. NEMA 4, NEMA 4X.
b. Fabricated from 14-gauge type 304 stainless steel.
c. All seams continuously welded.
d. Door shall have a rolled lip around three (3) sides:
   1) Attached to enclosure by means of a continuous stainless steel hinge and pin.
e. Neoprene door gasket to provide a watertight seal:
   1) Attached with an adhesive.
   2) Retained by a retaining strip.
f. All external removable hardware shall be fabricated from heavy gauge stainless steel which shall clamp the door to the enclosure body.
g. With a hasp and staple for padlocking.
h. With a removable print pocket.
i. Internal panels.
   1) With stainless steel shoulder studs for mounting an internal panel.
   2) Mounting panels shall be stainless steel.
j. Large enclosures shall have door and body stiffeners for extra rigidity.
k. With no holes or knockouts.
l. Finish:
   1) Brushed.
m. Stainless steel external mounting brackets when surface mounted.
n. Floor stand kit when shown:
   1) Fabricated from 12-gauge stainless steel.

2) Bottom plate 11-gauge.
3) Heights:
a) 6".
b) 12".
c) 18".
d) 24".
4) When a floor stand kit is used, the box shall not have any external mounting brackets.

o. As manufactured by:
1) Hoffman.
2) Thomas & Betts.
3) Stahlin.
4) Rittal.

J. Cast Iron Junction Boxes.
1. NEMA 4.
2. Recessed cover boxes.
3. Suitable for use outdoors where subject to rain, dripping, or splashing water.
4. Designed for flush mounting in walls or floors.
a. Can be surface mounted using mounting lugs.
5. Construction:
a. Cast iron box.
b. Covers.
1) Checkered plate covers suitable for foot traffic.
2) When used in areas subject to vehicular traffic H-20 loading.
c. Hot dip galvanized.
d. Neoprene gasket.
e. Stainless steel screw covers.
6. As manufactured by:
a. Floor boxes shall be OZ Gedney, Type YR, or approved equal.
b. Surface boxes shall be OZ Gedney, Type YL or YF, or approved equal.

K. Boxes Serving Fixtures or Devices.
1. Use as pull boxes wherever possible.

L. In Finished Areas.
1. Provide specific pull or junction boxes only as indicated or directed.

M. Floor type outlet boxes shall be watertight cast iron, semi-adjustable.
1. Hubbell Type B25 with S2530 cover plate.
2. Telephone outlets shall be fitted with six (6) inch bushed nipples.
3. Floor outlets in open areas for service to desks shall be similar except that the Contractor shall provide pedestal housing.
a. Hubbell SC-3098, with plate SS-309-D for power.
b. Hubbell SC-3098, with plate SS-309-T for telephone.

N. Outlet boxes shall be used as junction boxes wherever possible.

O. Where separate pull boxes are required, they shall have screw covers.

P. Outdoor boxes shall be galvanized and provided with gasketed covers and threaded hubs.

Q. Indoor boxes shall be painted, as identified and in accordance with the painting schedule.

R. For boxes not indicated:
1. Provide types and mountings as required to suit the equipment and that will be consistent with the conduit system, used or as directed.
2. Outlet, switch, and junction boxes for flush-mounting in general purpose locations shall be one-piece, galvanized, pressed steel.
3. Ceiling boxes for flush mounting in concrete shall be deep, galvanized, pressed steel.
4. Outlet, switch, and junction boxes where surface mounted in exposed locations shall be cast ferrous boxes with mounting lugs, zinc or cadmium plating, and enamel finish.
5. Surface mounted boxes in concealed locations may be pressed steel.
6. Outlet, control station, and junction boxes, including covers, for installation in corrosive locations shall be fiberglass reinforced polyester, stainless steel, or plastic coated steel to match the conduit system, and shall be furnished with mounting lugs.
7. All cast boxes and pressed steel boxes for flush-mounting in concrete shall be fitted with cast, malleable box covers and gaskets.
8. Boxes for installation in plastered areas shall be stainless steel over plaster rings.

S. Recessed Boxes
1. Support recessed boxes in suspended ceilings or stud partitions with galvanized steel box hangers of types made specifically for the purpose or attach directly to wood members or blocking.
2. Secure hangers or boxes to wood with 1" long cadmium-plated, Type A pan head screws. Fully or partially hammer-driven screws are not acceptable.

2.2 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.
1. Color of Frame and Cover: Gray.
2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having a structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC" or "TELEPHONE" as required for each service.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass, or a combination of the two.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
a. Armorcast Products Company.
b. Carson Industries LLC.

c. CDR Systems Corporation.
d. NewBasis.

C. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
a. Armorcast Products Company.
b. Carson Industries LLC.
c. Christy Concrete Products.
d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete, reinforced concrete, cast iron, hot-dip galvanized-steel diamond plate.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
a. Carson Industries LLC.
b. Christy Concrete Products.
c. Nordic Fiberglass, Inc.

2.3 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional Engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 APPLICATON

A. Apply conduit bodies and boxes as required by NFPA 70, National Electrical Code.

B. NEMA classification for boxes in specific areas are as specified in Section 26 00 00.

3.2 INSTALLATION

A. Where Engineer's documents do not dictate location or control, consult with the trades concerned so that outlets may be symmetrically placed in the finished module.

B. Center outlets horizontally in vertical wall panels and vertically in masonry courses.

C. Use plastic boxes in corrosive areas where the conduit system specified is PVC.

D. In general, boxes shall conform to same materials as conduit system specified.

E. All boxes and or devices mounted on walls of areas classified as wet or corrosive shall be supported, so as to maintain a minimum of 0.25" free air space between the back of the enclosure and the wall.
   1. Use machined spacers to maintain air space. Built-up washers are not acceptable.
   2. Use stainless steel, steel that is completely electro-galvanized, or nylon materials for spacers.

F. Use cast malleable iron boxes when box must support other devices.

G. Use plastic coated malleable iron boxes when used with PVC jacketed rigid steel conduit.

3.3 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth, coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors, and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

END OF SECTION

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SECTION 26 05 34
CONDUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

A. American National Standards Institute:
   1. ANSI C80.1 – Rigid Steel Conduit – Zinc Coated.
   2. ANSI C80.3 – Electrical Metallic Tubing – Zinc Coated.

B. ASTM International.

C. International Organization for Standardization.

D. National Electrical Contractors Association.

E. National Electrical Manufacturers Association:
   1. NEMA RN-1 – Polyvinyl Chloride (PVC) Externally Ceoated Galvanized Rigid Steel Conduit and Intermediate Steel Conduit.
   2. NEMA TC2 – Electrical Plastic Tubing and Conduit.
   3. NEMA TC3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.
   4. NEMA TC13 – Electrical Nonmetallic Tubing.

F. National Fire Protection Association:
   1. NFPA 70, National Electrical Code:
      a. Table 300.5 – Minimum Cover Requirements (0 to 600 volts, Nominal)
      b. Table 300.50 – Minimum Cover Requirements (over 600 volts, Nominal)
      c. Article 344 – Rigid Metal Conduit (RMC).
      d. Article 348 – Flexible Metal Conduit (FMC).
      e. Article 350 – Liquidtight Flexible Metal Conduit (LFMC)
      f. Article 352 – Rigid Polyvinyl Chloride Conduit (PVC).
      g. Article 356 - Liquidtight Flexible Nonmetallic Conduit (LFNC).
      h. Article 358 – Electrical Metallic Tubing (EMT)
      i. Article 360 – Flexible Metallic Tubing (FMT).
      j. Article 362 – Flexible Non-metallic Tubing (ENT).
      k. Article 500 – Hazardous (Classified) Locations.

G. Society of Cable Telecommunication Engineers.

H. Underwriters Laboratories Inc:
   1. UL 1 – Standard for Safety for Flexible Metal Conduit.
   2. UL 6 – Standard for Safety for Rigid Metal Conduit.
   3. UL 360 – Standard for Safety for Liquid-Tight Flexible Steel Conduit.

4. UL 651 – Standard for Safety for Schedule 40 and 80 Rigid PVC Conduit.
5. UL 1660 – Standard for Safety for Liquid-Tight Flexible Nonmetallic Conduit.
6. UL 1653 – Standard for Safety for Electrical Nonmetallic Tubing.
7. UL 94VO – Standard for Vertical Flame Test.

1.3 SUMMARY

A. Section Includes:
   1. Conduits:
      a. Metallic Conduits:
         1) Galvanized Rigid Steel Conduit (GRC).
         2) Polyvinyl Chloride Coated Rigid Steel Conduit (PCS).
         3) Flexible Metal Conduit (FMC).
         4) Liquidtight Flexible Metal Conduit (LFMC).
      b. Non-metallic Conduits.
         1) Rigid Polyvinyl Chloride Conduit (PVC).
         2) Electrical Non-metallic Tubing (ENT).
         3) Liquidtight Flexible non-metallic (LFNC).
   2. Conduit fittings and accessories.
   3. Conduit installation.

B. Related Sections include the following:
   1. Section 26 00 00 “Electrical General Provisions”.
   2. Section 26 05 33 “Conduit Bodies and Outlet Boxes”.

1.4 DEFINITIONS

A. Definitions of terms are specified in Section 26 00 00 and noted herein.

B. Abbreviations:
   1. EMT: Electrical metallic tubing.
   2. EPDM: Ethylene-propylene-diene terpolymer rubber.
   3. FMC: Flexible metal conduit.
   4. GRC: Galvanized rigid steel conduit.
   5. LFMC: Liquidtight flexible metal conduit.
   6. NBR: Acrylonitrile-butadiene rubber.
   7. PCS: PVC coated rigid Steel Conduit.
   8. PVC: Polyvinyl chloride rigid nonmetallic conduit.

C. Conduit Bodies:
   1. A separate portion of a conduit system that provides access through a removable cover to the interior of the system at a junction of two or more sections of the system. Includes, but not limited to: shapes – C, E, LB, T, X, etc.

D. Conduit Fitting:
   1. An accessory that serves primarily a mechanical purpose. Includes, but not limited to: bushings, locknuts, hubs, couplings, reducers, etc.

1.5 SYSTEM DESCRIPTION

A. Furnish and install conduits, conduit bodies, fittings, junction boxes and all necessary components, whether or not indicated on the Drawings, as required, to install a complete electrical raceway system.

B. The Electrical Plans are Diagrammatic in Nature:
   1. Changes in conduit locations that are consistent with the design intent but are dimensionally different, or routing to bypass obstructions which differ from what is indicated on the Drawings are not considered a deviation.
   2. Relocation of electrical equipment that affects the conduit routing or changes in routing to bypass obstructions is not considered a change or deviation.
   3. The Engineer shall be the sole source in determining whether the change is constituted as a deviation.
   4. Any deviation requires Engineer's approval.

C. The Contractor shall bear the sole responsibility of any deviations in generation location, conduit size, routing, or changes to the conduit schedule without the express written approval or direction by the Engineer.
   1. Any changes resulting in additional conduits, or extra work from such deviations performed by the Contractor.
   2. Such deviations made by the Contractor shall be reflected on the Contractor supplied "As-built Drawings".
   3. Owner shall have the right to deduct the amount of applicable reimbursement, equivalent to the cost of the engineering effort required to show those unauthorized changes on Record Drawings.

1.6 SUBMITTALS

A. Furnish complete submittals in accordance with Section 26 00 00.

B. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
   1. Furnish complete manufacturer's catalog sheets for each product to be used on this project.
   2. Furnish complete manufacturer's recommended special tools to be used for installation if required.

C. As-built Drawings:
   1. Structural members in the paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

D. Source quality-control test reports.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, HANDLING

A. Do not expose type PVC, FRD, NFC and ENT to direct sunlight.

B. Do not store conduit in direct contact with the ground.

1.9 PROJECT/SITE CONDITIONS

A. As specified in Section 26 00 00.

1.10 SEQUENCING

A. Before installing any conduit or locating any device box.
   1. Examine the complete set of Contract Drawings and Specifications, and all applicable shop Drawings.
   2. Verify all dimensions and space requirements and make any minor adjustments to the conduit system as required to avoid conflicts with the building structure, other equipment, or the work of other trades.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems, Inc.
   2. Alflex Inc.
   3. Allied Tube & Conduit; a Tyco International Ltd. Co.
   4. Anamet Electrical, Inc.; Anaconda Metal Hose.
   5. Electri-Flex Co.
   6. Manhattan/CDT/Cole-Flex.
   7. Maverick Tube Corporation.
   8. OCAL, Inc.
   9. O-Z Gedney; a unit of General Signal.
   10. Perma Kote.
   11. Robroy Industries.
   12. Wheatland Tube Company.

B. Galvanized Rigid Steel Conduit and Couplings (GRC):
   1. Shall comply with the following standards:
      a. ANSI C80.1 Standard for Rigid Steel Conduit – Zinc Coated.
      b. UL-6 Safety Standard for Rigid Metal Conduit.
   2. All threads: NPT standard conduit threads with a ¾-inch taper per foot:
      a. Running conduit threads are not acceptable.
   3. Hot-dip galvanized inside and out, including threads, with chromate final coating..
      a. Electro-galvanizing is not acceptable.

C. PVC-Coated Rigid Steel Conduit (PCS):
   1. The steel conduit, before PVC coating, shall be new, unused, hot-dip galvanized material and shall conform to the requirements for type GRC.
   2. Coated conduit conforms to NEMA Standard RN-1, the galvanized coating may not be disturbed or reduced in thickness during the cleaning and preparatory process.
   3. Factory bonded PVC jacket of 0.040-inch minimum thickness.
      a. The conduit system to make use of pre-jacketed couplings, elbows etc.
      b. PVC coating on conduit and associated fittings shall have no sages, blisters, lumps, or other surface defects and shall be free of holes and holidays.
   4. The PVC adhesive bond on conduit and fittings shall be greater than the tensile strength of the PVC plastic coating. Confirm bond by certified test results.
   5. A urethane coating shall be uniformly and consistently applied to the interior of all conduit and fittings. This internal coating shall be a nominal thickness of 0.002 inch. Conduit having areas with thin or no coating shall be unacceptable.
   6. The PVC exterior and urethane interior coatings applied to the conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperature above 30 degrees Fahrenheit (-1 degrees Celsius).
   7. The conduit threads shall be hot-dip galvanized or shall be galvanized after fabrication and coating of the conduit using a method that ensures complete coverage and heats the zinc and steel to a temperature that ensures the zinc alloys with the steel over the entire surface. All threads shall be coated with urethane.
   8. The exterior galvanized surfaces shall be coated with primer before PVC coating to ensure a bond between the zinc substrate and the PVC coating.
   9. Nominal thickness of the exterior PVC coating shall be 0.040 inches thick except where part configuration or application of the piece dictated otherwise.
   10. PCS Couplings:
      a. The conduit coupling, before plastic coating, shall be new, unused material and shall conform to appropriate UL standards.
      b. The PVC Coating on the outside of conduit couplings shall be 0.040 inches thick and have a series of longitudinal ribs to protect the coating from tool damage during installation.
      c. A PVC sleeve extending 1 pipe diameter or 2 inches, whichever is less, shall be formed at each female conduit opening of the couplings.
   11. The exterior PVC coating and the interior urethane coatings shall be factory supplied by the same manufacturer.

D. Electrical Metallic Tubing (EMT): ANSI C80.3.
   1. Minimum size ¾-inch.

E. Liquid Tight Flexible Metal Conduit (LFMC):
   1. Conforms to the following standards:
      a. UL 360.
   2. Available in the following configurations:
      a. General Purpose:
         1) Temperature range -20 degrees Celsius to +80 degrees Celsius.
      b. Oil Resistant:
         1) Temperature range -20 degrees Celsius to +60 degrees Celsius.
      c. Computer Room:
         1) Temperature range -20 degrees Celsius to +80 degrees Celsius.

d. Temperature rated.

3. Sunlight resistant, weatherproof, and watertight.
4. Manufactured from single strip steel, hot dip galvanized on all four sides before conduit fabrication.
5. Strip steel spiral wound resulting in an interior that is smooth and clean for easy wire pulling.
6. With an overall polyvinyl chloride jacket.
7. With integral copper ground wire, built in the core, in conduit trade sizes ½-inch through 1-1/4-inch.
8. Minimum size ½-inch.

F. Flexible Metal Conduit (FMC)

1. Materials:
   a. Single strip steel hot-dip galvanized on all four sides before conduit fabrication.
   b. Full wall:
      1) Reduced wall thickness not allowed.
2. Interlocking design formed from continuous metal strip for integrity and flexibility.
3. UL conduits through penetration fire wall rating:
   a. 3-hour rated for steel.
   b. 2-hour rated for aluminum.
4. UL rated for Cable Tray and Environmental Air-Handling Space requirements.
5. Minimum size ¾-inch.

G. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Galvanized Rigid Steel Conduit Expansion Fitting for Exposed Locations:
   a. Suitable for use with conduit system being used.
2. Galvanized Rigid Steel Conduit Expansion Fittings at Structural Exposed Joints:
   a. Suitable for use with conduit system being used.
3. Conduit Sleeve:
   a. Suitable for use with conduit system being used.
4. Conduit Seals:
   a. Installed at locations as indicated on the Drawings, in the specifications and as required by NEC.
   b. Suitable for use with conduit system being used.
5. Conduit Thru-wall Seals:
   a. Installed at locations as indicated on the Drawings, in the specifications and as required by NEC.
   b. Suitable for use with conduit system being used.
6. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
7. Fittings for EMT: Set-screw or compression type.
8. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems, Inc.
   2. Anamet Electrical, Inc.; Anaconda Metal Hose.
   3. Arnco Corporation.
   4. CANTEX Inc.
   5. CertainTeed Corp.; Pipe & Plastics Group.
   6. Condux International, Inc.
   7. ElecSYS, Inc.
   8. Electri-Flex Co.
   9. Lamson & Sessions; Carlon Electrical Products.
   10. Manhattan/CDT/Cole-Flex.
   11. RACO; a Hubbell Company.
   12. Thomas & Betts Corporation.

B. Rigid Polyvinyl Chloride Conduit (PVC):
   1. Shall be NEMA TC 2, Type EPC-40-PVC**,** unless otherwise indicated.
   2. Rated for 90 degrees Celsius conductors or cable

C. Liquidtight Flexible Non-metallic Conduit (LFNC):
   1. Provide liquid-tight and corrosion resistant flexible-non-metallic conduit and fittings.
   2. Fabricated from a hard PVC spiral completely surrounded by flexible PVC:
      a. UL listed for sunlight resistance.
      b. Suitable for use at conduit temperatures of 80 degrees Celsius dry, 60 degrees Celsius wet and 60 degrees Celsius oil resistant.
   3. Temperature Range -20 degrees Celsius to +80 degrees Celsius.

D. Electrical Non-metallic Tubing (ENT):
   1. Corrugated thermoplastic construction.
   2. Trades sizes ½-inch through 2-inch.

E. Fittings: NEMA TC 3; match to conduit or tubing type and material.

2.3 ACCESSORIES

A. Connectors and Fittings:
   1. Manufactured with compatible materials to the corresponding conduit.

B. Insulated Throat Metallic Bushings:
   1. Construction:
      a. Malleable iron or zinc plated steel when used with steel conduit, with a positive metallic conduit end stop.
      b. Integrally molded non-combustible phenolic insulated surfaces rated 150 degrees Celsius.
      c. Use fully insulated bushings on non-metallic conduit system made of high impact 150 degrees Celsius rated non-combustible thermosetting phenolic.

C. Insulated Grounding Bushings:
   1. Construction:
      a. Malleable iron or steel, zinc plated, with a positive metallic end stop.
      b. Integrally molded non-combustible phenolic insulated surfaces rated 150 degrees Celsius.
      c. Tin plated copper grounding saddle for use with copper or aluminum conductions.

D. Electrical Unions (Erickson Couplings):
   1. Construction:
      a. Malleable iron hot dip galvanized for use with steel conduit.
      b. Aluminum for use with aluminum conduit.
      c. Concrete tight, 3-piece construction.
      d. Rated for Class 1 Division Group D I hazardous areas.

E. PVC Coated Rigid Steel Conduit (PCS) Fittings:
   1. All hollow conduit fittings, which serve as part of the PCS conduit system must be coated with an exterior PVC coating and interior urethane coating as described for the conduit.
   2. The conduit fitting, before plastic coating, shall be new, unused material and shall conform to appropriate UL standards.
   3. A PVC sleeve extending one pipe diameter or two inches, whichever is less, shall be formed at every female conduit opening on fittings except unions. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used.
   4. Flexible overlapping sleeves on all hubs and couplings shall provide a vapor and moisture tight seal at every connection.

F. Liquidtight Flexible Metal Conduit (LFMC) Fittings:
   1. Construction:
      a. Malleable iron hot dip galvanized.
      b. Furnished with locknut and sealing ring.
      c. Liquidtight, rain-tight, oil-tight.
      d. Insulated throat.
      e. Furnish as straight, 45 degree elbows and 90 degree elbows.
      f. Designed to prevent sleeving:
         1) Verify complete bonding of the raceway jacket to the plastic gasket seal.
      g. Equipped with grounding device to provide ground continuity irrespective of raceway core construction. Grounding device if inserted into raceway and directly in contact with conductors shall have rolled over edges for sizes under 5 inches.
      h. Where terminated into a threadless opening using a threaded hub fitting, a suitable moisture resistant/oil resistant synthetic rubber gasket shall be provided between the outside of the box or enclosure and the fitting shoulder. Gasket shall be adequately protected by and permanently bonded to a metallic retainer.

G. Corrosion Resistant and Outdoor Liquidtight Flexible Metal Conduit (LFMC) Fittings:

1. Construction:
    a. PVC coated liquid-tight fittings with a bonded 0.04 inch thick PVC coating on the metal connector to form a seal around the SLT conduits.
    b. Connectors shall have an insulated throat and an integral sealing ring.

H. Hubs for Threaded Attachment of Steel Conduit to Sheet Metal Enclosures:
1. Construction:
    a. Shall have an insulated throat.
    b. When used in corrosive areas shall be PVC coated.
    c. Bonding locknut.
    d. Recessed neoprene o-ring to assure watertight and dust tight connector.
    e. 1/2-inch through 1-1/4-inch steel zinc electroplated.
    f. 1-1/2-inch through 6-inch malleable iron zinc plated.
    g. Aluminum with aluminum conduit.
2. Usage:
    a. All conduits in damp, wet, outdoor, and corrosive areas shall use threaded hubs for connections to sheet metal enclosures.

I. Sealing Fittings:
1. Construction:
    a. When used in corrosive areas shall be PVC coated.
    b. Malleable ductile iron with steel conduit.
    c. Aluminum with aluminum conduit.
    d. Crouse-Hinds Type EYD where drains are required.
    e. Crouse-Hinds Type EYS where drains are not required.
    f. UL listed for use in Class 1, Division 1, Groups A, B, C, D; Class 1, Division 2, Groups A, B, C, C; Class 2, Divisions 1 and 2; Groups E, F, and G.

J. PVC Fittings:
1. Shall include the following:
    a. Couplings.
    b. Terminal Adapters.
    c. Female Adapters.
    d. Caps.
    e. Reducer Bushings.
    f. Duct Couplings.
    g. Eng Bells.
    h. Expansion Couplings.
    i. Duct Couplings 5 degree.
    j. C – Pull Fittings.
    k. E – Pull Fittings.
    l. LB – Pull Fittings.
    m. LL – Pull Fittings.
    n. LR – Pull Fittings.
    o. T – Pull Fittings.
    p. X – Pull Fittings.
2. Materials:
    a. All devices shall be made of PVC, using the same materials as used for Type PVC conduit.

b. All metal hardware shall be stainless steel.

K. Through Wall and Floor Seals:
1. Materials
a. Body.
b. Grommet – neoprene.
c. Pressure rings – PVC coated steel.
d. Disc material – PVC coated steel.
e. Aluminum when used with conduit type RAC.

L. Expansion/Deflection Couplings:
1. Use to compensate for movement in any directions between two conduit ends that they connect.
2. Shall allow movement of ¾-inch from the normal in all directions.
3. Shall allow angular movement for a deflection of 30 degrees from normal in any direction.
4. Materials:
a. End couplings – Bronze.
b. Sleeve – Neoprene.
c. Bands – Stainless Steel.
d. Bonding Jumper – Tinned copper braid.

M. Expansion Couplings:
1. Shall allow for expansion and contraction of conduit:
a. Permitting 8-inch movement, 4 inches in either direction.
2. Materials:
a. Head – Malleable or ductile iron.
b. Sleeve – Steel.
c. Insulating Bushing – Phenolic.
d. Finish – Hot dip galvanized.

2.4 METAL WIREWAYS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type shall comply with area as specified in section 26 00 00 “Electrical General Provisions”, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type or as indicated.

E. Finish: Manufacturer's standard enamel finish.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Apply raceway products as required by NFPA 70 – National Electrical Code and as specified in section 26 00 00 "Electrical General Provisions"

B. Minimum Raceway Size: 3/4-inch trade size.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

D. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

E. Do not install aluminum conduits in contact with concrete.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Conduit Installation General:
   1. Every installer of PVC coated Aluminum (PCA) or Rigid Steel (PCS) conduits shall be certified by the manufacturer for installation of the conduit.
   2. Install conduit runs in accordance with schematic representation as indicated on the Drawings and as specified. Modify conduit runs to suit field conditions, as accepted by the Engineer.
   3. Install complete conduit systems between outlets, boxes, and circuit source before conductors are installed.
   4. Install conduit runs for lighting and receptacle circuits, whether or not indicated on the Drawings.
   5. For conduit not specifically identified, i.e., lighting and receptacle conduits in process areas, the lighting and receptacle conduit materials shall match those selected for the power and process control systems.
   6. Use conduit size and type as identified in the Drawings.
   7. Route conduit to avoid drains or other gravity lines. Where conflicts occur, relocate conduit as required, at no additional cost to the Owner.
   8. Adequate clearances from high-temperature surfaces shall be provided for all conduit runs. Provide clearances as follows:
      a. Clearances of 6 inches from surfaces 113 degrees Fahrenheit to 149 degrees Fahrenheit.

b. Clearances of 12 inches from surfaces greater than 149 degrees Fahrenheit.
c. Keep conduit at least 6 inches from the coverings on hot water and steam pipes, 18 inches from the coverings on flues and breechings and 12 inches from fuel lines and gas lines.
d. Where it is necessary to route conduit close to high-temperature surfaces, a high-reflectance thermal barrier should be installed between the conduit and the surface.

9. Support conduit runs on water-bearing walls a minimum of 1 inch away from wall on an accepted channel. Use hot-dip galvanized steel or stainless steel channel, consistent with type of conduit being installed. Do not run conduit within water-bearing walls unless otherwise indicated on the Drawings.
10. All conduit to be concealed except for straight run from floor penetration to equipment. Contractor to request permission of the Engineer before running any other exposed conduit.
11. Run conduit exposed to view parallel with or at right angles to structural members, walls, or lines of the building. Install straight and true conduit runs with uniform and symmetrical elbows, offsets, and bends. Make changes in direction with long radius bends of with conduit bodies. Turn conduits with neat symmetrical bends.
12. Route all exposed conduit to preserve headroom, access space and work space and to prevent tripping hazards and clearance problems. Install conduit runs so that runs do not interfere with proper and safe operation of equipment and not block or interfere with ingress or egress, including equipment removal hatches.
13. Conduit may be run in concrete members or slabs with permission of the Engineer, provided the outside diameter does not exceed 1/3 of the thickness of the concrete. Locate such conduit in the center of the concrete or where the minimum concrete cover will be 1 conduit diameter. Space conduits at least 3 diameters apart on centers. As a general rule, conduit may not cross other conduit at pipe in concrete members or slabs.
14. When installing conduit through existing slabs or walls make provisions for locating any possible conflicting items where conduit is to penetrate. Use tone signal or X-ray methods to make certain that no penetrations will be made into existing conduit, piping, cables, post-tensioning cables etc.
15. Conduit runs between pull boxes or junction boxes:
    a. Total bends equaling not more than 270 degrees.
    b. Install NEC required pull boxes at locations acceptable for the Engineer.
    c. Plug conduits brought into pull boxes, manholes, handholes, and other openings until used to prevent entrance of moisture.
    d. Cap spare conduits and provide plastic pulling tape below threaded cap.
    e. Provide bonding bushing and bond wire.
16. Install conduit thruwall seals where indicated on the Drawings.
17. For existing and new 2 inch and larger conduit runs, snake conduits with conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of conduit. Remove and replace conduits through which mandrel will not pass. Clean and make certain that new and existing conduit runs are not crushed or creased.
18. Conduit Sizes shall be in accordance with the NEC or specified as follows unless otherwise indicated on the Drawings:
    a. Concealed conduit in partitions or accessible ceilings: Minimum ¾ inch.
    b. Exposed Conduit: Minimum ¾ inch.

c. Rigid Steel (RGC or PSC) encased in Concrete: Minimum 1 inch.
d. Rigid PVC Encased in Concrete
e. Liquidtite and Flex Conduit Minimum ½-inch.

19. The Contractor shall be responsible for providing all sleeves and openings required for the passage of electrical raceways or cables even when these openings or sleeves are not specifically shown on the Drawings.

C. Corrosive Areas:
1. Use conduit system as indicated on the Conduit Schedules.
a. Install PCS in corrosive areas where conduit may need to be self-supporting or where subject to mechanical damage.
b. Use liquid tight flexible conduits (SLT or NFC) and corrosion resistant connectors.
c. GRC where area and conduit are to be painted using an epoxy based paint.

D. Conduit Usage:
1. General Conditions:
a. Except as otherwise indicated, provide the type of conduit legally permitted or required for each location or condition.
b. Seal ends of all conduit with approved, manufactured conduit seals, caps or plugs immediately after installation. Keep ends sealed until immediately before pulling conductors.
c. Conduit sizes not indicated in the schedule or on the Drawings shall be in accordance with NEC requirements and shall be sized based on quantities of sizes of wire installed therein, including the insulated grounding conductor.
d. Conduit types not specified shall be consistent with other conduit systems in the area, the area classifications, and enclosure requirements.
e. Use insulated metallic bushings for all metallic conduit.
2. Underground and Embedded Conduits:
a. Install minimum 2-inch ductbank conduit, unless otherwise indicated on the Drawings.
b. Use types and systems as indicated on the Drawings.
1) PVC Schedule 40 in embedded locations and underground in ductbanks.
c. Use Type PCS or PVC wrapped GRC conduit and elbows for underground and embedded installations as follows:
1) Stub-up and risers to grade floor or equipment from non-metallic conduits.
2) Entering and exiting underground conduit runs a minimum 12 inches above and below grade or finished floor.
3) All 90-degree elbows with a bend radius of 12 inches or less.
d. Install underground conduits in conformance with Section 26 00 00 “Electrical General Provisions”, and as shown or required on the Drawings.
e. Make conduit size transitions at pullboxes and manholes for underground conduits.
f. Install spare conduits in underground duct banks towards top center of runs to allow for ease of installation of future cables as conduits enter underground manholes and pullboxes.
3. PVC Coated Rigid Steel Conduit (PCS):

a. Use Type PCS in locations as identified in specification 26 00 00 “Electrical General Provisions” and as shown or required on the drawings
b. Use specifically manufactured or machined threading dies to manufacturer’s specifications to accommodate the PVC jacket.
c. Use only manufactured approved tools for clamping conduit.

4. Galvanized Rigid Steel Conduit (GRC):
   a. Use Type GRC in locations as identified in specification 26 00 00 “Electrical General Provisions” and as shown or required on the drawings.
   b. Conduit shall be cut square and reamed before threading.
5. Flexible Conduit:
   a. Use flexible conduit for short lengths for final connections between rigid conduit and motors, vibrating equipment, instruments, control equipment or where required for equipment servicing.
   b. Maximum length of flexible conduit 36 inches.
   c. Use Type LFMC in wet and damp locations, areas exposed to the weather, corrosive areas where NEMA 4X construction is required and conduit type is PCS, or as indicated on the Drawings or conduit schedule, provided the jacket temperature limitations will not be exceeded:
      1) Use UL sunlight resistant outdoors and in the presence of ultraviolet lights.
   d. Use type LFNC in all corrosive atmospheres where conduit type is PVC and where indicated on the plans or conduit schedule.
   e. Use explosion proof flexible conduit in Class I Division hazardous areas. In Class 1, Division 1 areas, flexible fittings must be approved and marked suitable for Class 1, Division 1, and must also be listed for compatibility with the Group type atmosphere when used.
   f. In Class I, Division 2 areas, use liquidtight metal conduit with approved fittings.
      1) Maximum length of liquidtight metal conduit is 18 inches.
6. Non-Metallic Conduit (PVC):
   a. Conduit terminations shall be via threaded adapters into threaded hubs on the junction boxes or conduit bodes.
   b. Conduit terminations into boxes without threaded hubs shall utilize a threaded adapter and a flat neoprene washer on the outside of the box. Use a locknut on the inside of the box to tighten the adapter to the box:
      1) Flat washers as manufactured by Carlon, Type E943, DW, EW, FW, GW, HW, and JW.
   c. Install PVC conduit for exposed runs only when indicated on the Drawings. Route conduit so as to afford it the maximum physical protection. If necessary, cover conduit to afford additional protection when it cannot be shielded by the structure or machinery frames:
      1) Use schedule 80 where exposed runs may be subject to physical damage.
   d. Use UV resistant conduit where it can be exposed to ultraviolet light and in exposed outdoor areas.

E. Conduit Joints and Bends:
   1. General:

a. Where conduits are underground, under slabs on grade, exposed to the weather or in wet locations, make joints liquid tight and gas-tight.
b. Keep bends and offsets in conduit runs to an absolute minimum. For the serving utilities, make large radius ends to meet their requirements.
c. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
d. Bend conduit to radius as legally required.
e. All bends shall be symmetrical.
f. All of the following conduit systems shall use large radius sweep elbows:
    1) Underground conduits.
    2) Conduits containing medium voltage cables.
    3) Conduits containing shielded cables.
    4) Conduits containing fiber optic cables.

2. Threaded Conduit:
a. Cut threads on GRC, IMC, and RAC with a standard conduit cutting die that provides a ¾-inch per foot taper and to a length such that all bare metal exposed by the threading operation will be completely covered by the couplings or fittings used. In addition, cut the lengths of the thread such that all joints will become secure and wrench tight just preceding the point where the conduit ends would butt together in couplings or where conduit ends would butt into the ends or shoulders of other fittings.
b. Thoroughly ream conduit after threads have been cut to remove burrs. Seal joints with accepted conductive sealant compound and make watertight. Set up joints tight. Use bushings or conduit fittings at conduit terminations.
c. On exposed conduits, repair scratches and other defects with galvanizing repair stick, Enterprise Galvanizing "Galvabar" or CRC "Zinc It."
d. Threaded conduit joints shall be coated with an approved electrically conductive sealant and corrosion inhibitor that is not harmful to the conductor insulation.
    1) Use KOPR-Shield as manufactured by T&B on threads of ferrous conduit.
    2) Use AP* ALUMA-Shield as manufactured by T&B on threads of aluminum conduit.
    3) Apply to the male threads and tighten joints securely.
    4) Clean excess sealant from exposed threads after assembly.
e. Securely tighten all threaded connections.
f. Any exposed threaded surface must be cleaned and coated with a galvanizing solution so that all exposed surfaces have a galvanized protective coating before painting.
g. Provide large radius factory-made bends for 1-1/4-inch trade size or larger or field-bend the conduit with power bending equipment specifically intended for the purpose and made so that the conduit is not damaged and the internal diameter is not effectively reduced.
h. Bends should be made with a radius of not less than the requirements found in the NEC:
    1) The radius must be greater than the minimum bending radius of the cable.
    2) A field bend shall be made with power bending equipment or manual benders specifically intended for the purpose and made so that the

conduit is not damaged and the internal diameter is not effectively reduced.

3. Non-Metallic (PVC):
   a. Use approved solvent-weld cement specifically manufactured for the purpose. Spray type cement is not allowed.
4. Apply heat for bends so that conduit does not distort or discolor. Use a spring mandrel as required to assure full inside diameter at all bends.

F. Support raceways as specified below:
1. General:
   a. Provide appropriate hangers, supports, fasteners, and seismic restraints to suit applications.
   b. Support conduit at the intervals required by the NEC.
   c. Perforated strap and plumbers tape are not acceptable for conduit supports.
   d. Do not install one inch or larger conduits in or through structural members unless approved by the Engineer.
   e. Conduit fittings and supports are not shown on the Drawings. The Contractor shall provide all fittings and supports required to suit the conditions.
   f. Securely fasten exposed conduits with clamps or straps. Run exposed conduit on walls and ceilings only, parallel to planes of walls or ceilings. Do not run conduit diagonally.
2. Above Suspended Ceilings:
   a. Support conduit on or from the structure, conduit shall not be supported from hanging wires or suspended ceiling grid.
3. Concealed Conduit on Wood:
   a. Use 2-hole galvanized steel straps screwed or nailed to the wood or hammer-driven supports of the stamped galvanized type having serrated or sawtooth edges on the driven portion and designed specifically for the size and type of conduit being supported. Drive these latter supports so that the conduit is tightly and rigidly supported. Replace any dented or damaged conduit.
4. In Steel Stud Construction:
   a. Tie conduit at a maximum 4-foot intervals with No. 16 gauge double annealed galvanized wire so that conduit cannot move from vibration or other causes.
5. Conduit on Concrete or Masonry:
   a. Use 1-hole malleable iron straps with metallic or plastic expansion anchors and screws or support from preset inserts.
   b. Use preset inserts in concrete when possible.
   c. Use pipe spacers (clamp backs) in wet locations.
   d. On plaster or stucco, use 1-hole malleable iron straps with toggle bolts.
6. Conduit on Metal Decking:
   a. Use 1-hole malleable iron straps with 1-inch long cadmium-plated Type A panhead sheet metal screws. Fully or partially hammer-driven screws are not acceptable.
7. Suspended Conduit:
   a. Use malleable iron factory-made split-hinged pipe rings with threaded suspension rods sized for the weight to be carried (minimum 3/8-inch diameter), Kindorf, or equal.

b. For grouped conduits, construct racks with threaded rods and tiered angle-iron or Unistrut cross members. Clamp each conduit individually to a cross member. Where rods are more than 2 feet long, provide rigid sway bracing.

8. Supports at Structural Steel Members:
   a. Use beam clamps.
   b. Drilling or welding may be used only as indicated or with approval of the Engineer.
9. PVC Coated Rigid Steel Conduit (PCS) systems:
   a. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the coated conduit. All "U" bolts shall be supplied with PVC encapsulated nuts that cover the exposed portions of the threads.
   b. Securely fasten exposed PCS conduits with Type 316 stainless steel clamps or straps or PVC coated clamps or straps manufactured and supplied by the PCS conduit supplier.

G. EMT shall only be permitted when concealed within finished walls, and ceilings, of offices and control rooms unless otherwise indicated.

H. Expansion or Expansion/Deflection Fittings:
1. General:
   a. Align expansion coupling with the conduit run to prevent binding.
   b. Follow manufacturer's instructions to set the piston opening.
   c. Install expansion fittings across concrete expansion joints and at other locations where necessary to compensate for thermal or mechanical expansion and contraction as indicated on the Drawings.
   d. Shall be of the same material as the conduit system.
2. For metallic conduit (PCS, GRC and RAC) use expansion or expansion/deflection couplings, as appropriate, where:
   a. Conduit may be affected by dissimilar movements of the supporting structures or medium or conduit crosses building or structural expansion joints.
   b. These fittings shall be constructed in such a manner that will provide the continuity of the ground path in each conduit or raceway.
   c. Install expansion fittings a minimum of every 200 feet in straight conduit runs.
3. For PVC use expansion or expansion/deflection couplings, as appropriate, where length change due to temperature variation exceeds 2 inches:
   a. Rigidly fix the outer barrel of the expansion coupling so it cannot move.
   b. Mount the conduit connected to the piston loosely enough to allow the conduit to move as the temperature changes.

I. Empty Conduits:
1. Provide a polyethylene rope rated 250 pounds tensile strength in each empty conduit more than 10 feet in length.
2. Provide conduit marker tags for each spare conduit.

J. Miscellaneous:

1. Provide flashings and counter flashings or pitch pockets for waterproofing of raceways, outlets, fittings, and other items that penetrate the roof.
2. Electrical unions shall be used at all points of union between ends of rigid conduit systems that cannot otherwise by coupled. Running threads and threadless couplings shall not be used.
3. Transition fittings to mate steel conduit to PVC conduit, and PVC access fittings, shall be furnished by or as recommended by the manufacturer or the PVC conduit.
4. Where a transition between PVC conduit and rigid conduit systems is required, such transition shall be accomplished by means of a PCS elbow or a minimum 3 foot length of PCS conduit.
5. Any conduit installed that the Engineer determines does not meet the best practices of the trade shall be replaced by the Contractor at no cost to the Owner.

K. Field Conditions and Related Requirements:
1. Underground water table may be near or above the location of new ductbanks.
2. Contractor shall include cost for necessary dewatering, and cleaning equipment to perform work in underground ductbanks, pull boxes and manholes, before installation.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom with 6" of select backfill below the conduits. Select backfill shall pass through a ¾" sieve frame and contain less than 30 percent rock solids by volume.
2. Install select backfill around conduits and 18 inches above conduits.
3. Duct shall be assembled using high impact nonmetallic spacers and saddles to provide conduits with vertical and horizontal separation. Plastic spacers shall be set every 5 feet.
4. The duct shall be laid on a grade line of at least 4 inches per 100 feet, sloping towards pullboxes or manholes. Duct shall be installed and pullbox and manhole depths adjusted so that the top of the duct is a minimum of 24 inches below grade or as shown on the drawings.
5. Couplings shall be staggered at least 6 inches vertically.
6. Each bore of the completed duct bank shall be cleaned by drawing through it a standard flexible mandrel one foot long and 1/4-inch smaller than the nominal size of the duct through which the mandrel will be drawn. After passing of the mandrel, draw a wire brush and swab through.
7. A raceway, in the duct envelope, which does not require conductors, shall have a 1/8-inch polypropylene pull cord installed throughout the entire length of the raceway.
8. Duct bank penetration through walls of manholes or pullboxes, and on building walls below grade shall be watertight.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor. All underground rigid steel conduit shall be PVC-coated or taped.
    a. Couple steel conduits to ducts with adapters designed for this purpose.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or

foundation. Install insulated grounding bushings on terminations at equipment.

10. Warning Tape: Bury warning tape approximately 18 inches above direct-buried conduits. Align tape along the centerline of conduit bank.

B. Concrete-Encased Ducts: Support ducts on duct separators.

1. The type of concrete used is specified in section 26 00 00 "Electrical General Provisions.
2. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
3. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
4. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
5. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
6. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
7. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
8. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor. All underground rigid steel conduit shall be PVC-coated or taped.
    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

C. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.4 CONDUIT PENETRATIONS:

A. Conduit Penetrations on walls, concrete structures, pull boxes, and equipment cabinets shall be performed in accordance with the following:
   1. Seal all raceways entering structures at the first box or outlet with conduit sealant to prevent the entrance into the structure of gases, liquids, or rodents.
   2. Dry pack with nonshrink grout around raceways that penetrate concrete walls, floors, or ceilings aboveground, or use one of the methods indicated for underground penetrations.
   3. Where an underground conduit enters a structure through a concrete roof or a membrane waterproofed wall or floor, provide an acceptable, malleable iron, watertight, entrance sealing device. When there is no raceway concrete encasement, provide such device having a gland type sealing assembly at each end with pressure bushings which may be tightened at any time. When there is raceway concrete encasement indicated, provide such a device with a gland type sealing assembly on the accessible side. Securely anchor all such devices into the masonry construction with one or more integral flanges. Secure membrane waterproofing to such devices in a permanently watertight manner.
   4. Where an underground raceway without concrete encasement enters a structure through a nonwaterproofed wall or floor, install a sleeve made of Schedule 40 galvanized pipe. Fill the space between the conduit and sleeve with a suitable plastic expandable compound, or an oakum and lead joint, on each side of the wall or floor in such a manner as to prevent entrance of moisture. A watertight entrance sealing device may be used in lieu of the sleeve.

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials are specified in section 26 00 00 "Electrical General Provisions".

3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 05 36
CABLE TRAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes aluminum cable trays and accessories.

B. Related Sections include the following:
   1. Division 26 Section "Electrical General Provisions".

1.3 SUBMITTALS

A. Furnish complete submittals in accordance with Section 26 00 00.

B. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated.

C. Shop Drawings: For each type of cable tray.
   1. Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
   2. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
      a. Design Calculations: Calculate requirements for selecting seismic restraints.
      b. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

D. Coordination Drawings: Floor plans and sections, drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements. Show the following:
   1. Vertical and horizontal offsets and transitions.
   2. Clearances for access above and to side of cable trays.
   3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

E. Field quality-control reports.

F. Operation and Maintenance Data: For cable trays to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Aluminum cable tray may be stored outside without cover, but shall be loosely stacked, elevated off the ground, and ventilated to prevent staining during storage.

B. Store indoors to prevent water or other foreign materials from staining or adhering to cable tray. Unpack and dry wet materials before storage.

C. Steel cable tray shall be stored in a well-ventilated, dry location. Unpack and dry wet materials before storage.

D. PVC-coated cable tray shall be stored indoors. Protect cable tray from scratching and marring of finish. Unpack and dry wet materials before storage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.
   2. Legrand – Cablofil.

2.2 MATERIALS AND FINISHES

A. Cable Trays, Fittings, and Accessories: Steel, complying with NEMA VE 1.
   1. Aluminum

B. Cable Trays, Fittings, and Accessories: Aluminum, complying with NEMA VE 1, Aluminum Association's Alloy 6063-T6 for rails, rungs, and cable trays, and Alloy 5052-H32 or Alloy 6061-T6 for fabricated parts; with Type 316 stainless-steel splice-plate fasteners, bolts, and screws

C. Cable Trays, Fittings, and Accessories: Stainless steel, Type 316, complying with NEMA VE 1.

D. Sizes and Configurations: Refer to the Drawings for specific requirements for types, materials, sizes, and configurations.
   1. Center-hanger supports may be used only when specifically indicated.

2.3 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Covers: Solid 2-in-3 pitch cover type of same materials and finishes as cable tray.

C. Barrier Strips: Same materials and finishes as cable tray.

D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.4 WARNING SIGNS

A. Lettering: 1-1/2-inch- high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

B. Materials and fastening are specified in Division 26 Section "Electrical Identification."

2.5 SOURCE QUALITY CONTROL

A. Perform design and production tests according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Comply with recommendations in NEMA VE 2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.

B. Remove burrs and sharp edges from cable trays.

C. Fasten cable tray supports to building structure and install seismic restraints.
   1. Design each fastener and support to carry load indicated by seismic requirements and to comply with seismic-restraint details according to Division 01 Section "Seismic Design Criteria."
   2. Place supports so that spans do not exceed maximum spans on per manufacture's recommendations.
   3. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
   4. Support bus assembly to prevent twisting from eccentric loading.
   5. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3.

6. Locate and install supports according to NEMA VE 1.

D. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.

E. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in NEMA VE 1. Space connectors and set gaps according to applicable standard.

F. Make changes in direction and elevation using standard fittings.

G. Make cable tray connections using standard fittings.

H. Seal penetrations through fire and smoke barriers according to Division 7 Section "Firestopping."

I. Seal penetrations between rooms with custom removable aluminum barrier fabricated to tightly fit around cable tray.

J. Sleeves for Future Cables: Install capped sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

K. Workspace: Install cable trays with enough space to permit access for installing cables.

L. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

M. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.

3.2 CABLE INSTALLATION

A. Install cables only when cable tray installation has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties as recommended by NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. On vertical runs, fasten cables to tray every 18 inches. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

D. In existing construction, remove inactive or dead cables from cable tray.

E. Install covers after installation of cable is completed.

3.3 CONNECTIONS

A. Ground cable trays according to manufacturer's written instructions.

B. Install an insulated equipment grounding conductor with cable tray, in addition to those required by NFPA 70.

3.4 FIELD QUALITY CONTROL

A. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:
   1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable tray, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.
   2. Verify that the number, size, and voltage of cables in cable tray do not exceed that permitted by NFPA 70. Verify that communication or data-processing circuits are separated from power circuits by barriers.
   3. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.
   4. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.
   5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
   6. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
   7. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray.

B. Report results in writing.

3.5 PROTECTION

A. Protect installed cable trays.

B. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

C. Repair damage to PVC or paint finishes with matching touchup coating recommended by cable tray manufacturer.

D. Install temporary protection for cables in open trays to protect exposed cables from falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials until the risk of damage is over.

END OF SECTION

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SECTION 26 05 53
ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for identifying electrical, instrumentation, and process equipment and components.
   2. Material, manufacturing and installation requirements for identification devices.

B. Related Sections:
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.2 REFERENCE

A. Refer to Division 26, Section 26 00 00 “Electrical General Provisions” for a list of references.

1.3 DEFINITIONS

A. Definitions of terms are specified in Section 26 00 00.

1.4 SYSTEM DESCRIPTION

A. Nameplates:
   1. Provide a nameplate for each piece of electrical equipment, process equipment, valve, pump, mixer, feeder, fan, air-handling unit, motor, switch, receptacle, controller, instrument transducer, instrument power supply, solenoid, motor control center, starter, panelboard, switchboard, individually mounted or plug-in type circuit protector or motor controller, disconnect switch, bus duct tap switch, time switch, relay and for any other control device or major item of electrical equipment, either located in the field or within panels.
   2. All nameplates shall be of identical style, color, and material throughout the facility.
   3. Device nameplates shall include:
      a. Designations as shown on the drawings and identified on the Process and Instrumentation Drawings.
      b. Device tag and loop number ID (i.e. EDV-60.0101.01).
      c. Circuit ID (i.e. LPA-111).
      d. Area served (i.e. Lighting Chemical Building).
      e. Black lettering on white background, laminated plastic.

B. Wire Numbers:
   1. Coordinate the wire numbering system with all vendors of equipment so that every field wire has a unique number associated with it for the entire system:
      a. Wire numbers shall correspond to the wire numbers on the control drawings or the panel and circuit numbers for receptacles and lighting.

b. Wire numbers shall correspond to the terminal block number to which they are attached in the control panel.
c. Internal panel wires on a common terminal shall have the same wire number.
d. Multiconductor cables shall be assigned a cable number that shall be attached to the cable at intermediate pull boxes and stub-up locations beneath freestanding equipment. All multi-conductor and instrumentation cables shall be identified at pull points as described above:
    1) Label armored multiconductor cable using the conduit number as indicated on the drawings, following the requirements for conduit markers in Section 26 05 34 "Conduits."

2. Provide the following wiring numbering schemes throughout the project and used for field wires between Process Control Module (PCM's), Vendor Control Panels (VCP's), Motor Control Centers (MCC's), field starters, and field instruments:
    a. (ORIGIN LOC.)-(ORIGIN TERM.)/(DEST. LOC.)-(DEST. TERM.) OR
    b. (ORIGIN LOC.)-(ORIGIN TERM.)
    c. (DEST. LOC.)-(DEST. TERM.)
        1) ORIGIN LOC. = Designation for originating panel or device.
        2) ORIGIN TERM. = Terminal designation at originating panel or device.
        3) DEST. LOC. = Designation for destination panel or device.
        4) DEST. TERM. = Terminal designation at destination panel or device or PLC I/O address at destination panel.

3. Where:
    a. Identify equipment and field instruments as the origin.
    b. PCM's are always identified as the destination.
    c. Location is the panel designation for VCP, LCP, or PCM. For connections to MCC's, location is the specific starter tag and loop number. Location is the tag and loop number for motor starts, field instruments and equipment. Any hyphen in the panel designation or tag and loop number shall be omitted.
    d. Terminal designation is the actual number on the terminal block where the conductor terminates at field devices and vendor control panels. For multiconductor cables, all terminal numbers shall be shown, separated by commas.
    e. Terminal designations at motor leads shall be the motor manufacturer's standard terminal designation (i.e. T1, T2, T3, etc.).
    f. Terminal designations at PCM's where the field conductor connects to a PLC input or output shall be the PLC Address (Note: the following PLC I/O numbering scheme is typical for Allen Bradley, the numbering scheme should be modified to match that of the actual PLC manufacturer used for the project).
        1) Discrete point: W:X:Y/Z
        2) Analog point: W:X:Y.Z
            a) W = I for input, Q for output, AI for analog input, AQ, for analog output.
            b) X = PLC number (1, 2, 3….).
            c) Y = Slot number (01, 02, 03….).
            d) Z = Terminal number (00, 01, 02…) for a discrete point or a word numbering for an analog point (1,2,3…).

4. Where:
   g. Terminal designations at PCM's where the conductor does not connect to a PLC I/O point shall be the terminal number with a "C" prefix (i.e. C0010). For common power after a fuse or neutrals after a switch, the subsequent points shall have and capital letter suffix starting with A: (i.e. 0010A).
5. Case 1: Vendor Control Panel (VCP) to Process Control Module (PCM):
   a. Field wire number/label: A-B/C-D.
      1) Vendor Control Panel number without hyphen (VCP60.0101.01).
      2) Terminal number within VCP (manufacturer's or vendor's standard terminal number).
      3) Process Control Module number without hyphen (PCM60.0101).
      4) Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010).
         a) Examples: VCP60.0101.01-10/PCM60.0101-1:1:01/01
            VCP60.0101.01-10/PCM60.0101-0:1:01/10/07
            VCP60.0101.01-10/PCM60.0101-C0100
6. Case 2: Field Instrument to Process Control Module (PCM):
   a. Field wire number/label: E-F/C-D.
      1) Process Control Module number without hyphen (PCM60.0101).
      2) Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010).
      3) Field mounted instrument tag and loop numbers without hyphen (EDV60.0101.01).
      4) Manufacturer's standard terminal number within instrument. Use both terminal numbers for analog points separated by a comma.
         a) Examples: TIT60.0101.01-2,3/PCM60.0101-l:1:01.1
            TSH60.0101-1/PCM60.01001-l:2:01/00
7. Case 3: Motor Control Center (MCC) to Process Control Module (PCM):
   a. Field wire number/label: G-B/C-D.
      1) Terminal number within Motor Control Center (manufacturer's or vendor's standard terminal number).
      2) Process Control Module without hyphen (PCM60.0101).
      3) Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010).
      4) Actual Starter designation in the Motor Control Center without hyphen (MMS60.0101).
         a) Examples: MMS60.0101-10/PCM60.0101-I:01/01
            MMS60.0101-10/PCM60.0101-O:1:10/07
            MMS60.0101-10/PCM60.0101-C0100
8. Case 4: Motor Control Center (MCC) to Vendor Control Panel (VCP):
   a. Field wire number/label: G-B/A-B.
      1) Vendor Control Panel number without hyphen (BCP60.0101.01).
      2) Terminal number within motor control center, or vendor control panel.
      3) Manufacturer's or vendor's standard terminal number.

4) Actual Starter designation in the Motor Control Center without hyphen (MMS60.0101).
a) Examples: MMS60.0101-X2/VCP60.0101.01-10

9. Case 5: Motor leads to a Motor Control Center (MCC):
a. Field wire number/label: H-I/G-B.
1) Terminal number within motor control center (Manufacturer's standard terminal number).
2) Actual Starter designation in the Motor Control Center without hyphen (MMS60.0101).
3) Equipment tag and loop number without hyphen (PMP60.0101.01).
4) Motor manufacturer's standard motor lead identification (T1, T2, T3, etc.).
a) Examples: PMP-60.0101.01-T3/MMS60.0101.01-T3

10. Case 6: Remote or separately mounted starter or Variable Frequency Drive (VFD) to Process Control Module (PCM):
a. Terminal number within starter or Variable Frequency Drive (VFD) (manufacturer's standard terminal number).
b. Process Control Module number without hyphen (VCP60.0101.01).
c. Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC/I/O point (C0010).
d. Starter or Variable Frequency Drive tag and loop number without hyphen (MMS60.0101).
a) Examples: MMS60.0101-10/PCM60.0101-I:01/01
MMS60.0101-10/PCM60.0101-O:2:10/07
MMS60.0101-10/PCM60.0101-C0010

11. Case 7: Field Bus Trunk Segment:
a. Field cable number/label: C/K-L/M; C/K-L/H; C/K-L/J.
1) Process Control Module number without hyphen (PCM60.0101).
2) Field Bus Cable Type.
3) Field Bus Segment Number.
4) Field Bus Field Network Component, without hyphen (PTB1).
5) Equipment tag and loop number without hyphen (EMV61.1100.01).
6) Starter or Variable Frequency Drive tag and loop number without hyphen (VFD60.0101).
a) Examples: PCM60.0101/PA-1A/PTB1
PTB1/PA-1B/PTB2
PCM60.0101/DN-1A/VFD60.0112
PCM60.0101/DP-2A/EMV61.1100.01

10. Case 8: Field Bus Spur (Drop):
a. Field cable number/label: E/K-L/M.
1) E = Field mounted instrument tag and loop numbers without hyphen (FIT62.0110.02).
2) K = Field Bus Cable Type.
3) L = Field Bus Segment Number.
4) M = Field Bus Field Network Component without hyphen (PTB1), identify ports.
a) Examples: FIT62.0110.02/PA-1C/PTB1-1
FIT62.0110.02/PA-1D/PTB1-2

11. All spare conductors shall be terminated on terminal blocks and shall be identified as required for other field wires with an “S” prefix:
    Examples: A MMS60.0101-10/PCM60.0101.01-C011

C. Conduit Numbers:

1. Number the conduits as shown on the electrical standard detail drawing E-SD-6. See details E-5044 and E-5045.

1.5 SUBMITTALS

A. Furnish submittals in accordance with Sections 01 33 00 and 26 00 00.

B. Furnish complete product Data, Schedules, and Record Drawings submittals as specified below.

C. Nameplates:

1. Product Data:
   a. Color.
   b. Size:
      1) Outside dimensions.
      2) Lettering.
   c. Material.
   d. Mounting means.
2. Nameplate Schedule:
   a. Show exact wording for each nameplate.
   b. Include nameplate and letter sizes.

D. Wire Numbers:

1. Manufacturer’s catalog data for wire labels and label printer.

E. Record Drawings:

1. Update the conduit schedule to reflect the exact quantity of wire numbers including spares and destination points for all wires.

1.6 QUALITY ASSURANCE

A. Representatives of the Contractor, Owner, and Engineer shall convene before any major purchases of cable or conductors and before the installation or termination of any cables or conductors.

PART 2 – PRODUCTS

2.1 NOT USED

2.2 MATERIALS

A. Nameplates:
   1. Fabricated from white-center and black or red face laminated plastic engraving stock:
      a. 3/32-inch thick material.
      b. 2-ply.
      c. With chamfered edges.
      d. Engraved characters shall be of a block style, and of adequate size to be read easily from a distance of six (6) feet with no characters smaller than 1/8-inch in height.

B. Signs:
   1. Automatic Equipment and High-Voltage Signs.
      a. Shall be suitable for exterior use.
      b. Shall be in accordance with OSHA regulations.

C. Conductor and Cable Markers:
   1. Markers shall consist of machine printed, black characters on white tubing.
   2. Characters shall be no smaller than size 10 font.
   3. Characters shall be machine printed on tubing.

D. Conduit and Raceway Markers:
   1. UV resistant holder and letters.
   2. Black letters on yellow background.
   3. Minimum ½-inch high letters.

E. Medium Voltage Circuit Raceway Labels:

   1. Vinyl plastic.
   2. Minimum 1-inch high letters.

2.3 SOURCE QUALITY CONTROL

A. Nameplates:

   1. Provide all nameplates for control panel operator devices (i.e. pushbuttons, selector switches, pilot lights, etc.) using the same material and of the same color and appearance as the device nameplates, in order to achieve an aesthetically consistent and coordinated system.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Nameplates:

   1. Attach nameplates to equipment with stainless steel sheet metal screws, approved waterproof epoxy-based cement or install in metal holders welded to the equipment.
   2. In corrosive or wet areas use epoxy-based cement to attach nameplates.

3. Nameplates shall be aligned and level or plumb to within 1/64 inch over the entire length:
    a. Misaligned or crooked nameplates shall be remounted, or new enclosures shall be provided at the discretion of the Engineer.

B. Signs:

1. Automatic Equipment and High Voltage Signs:
    a. Mount permanent warning signs at mechanical equipment that may be started automatically from remote locations. Fasten warning signs with round head stainless steel screws or bolts. Locate and mount warning signs in a suitable manner that is acceptable to the Engineer.
    b. Mount permanent and conspicuous warning signs on the front and back of equipment, doorways to equipment rooms, pull boxes, and manholes where the voltage exceeds 600 V.
    c. Place warning signs on equipment that has more than one source of power:
        1) Warning sign to identify every power source.
    d. Place warning signs on equipment that has a 120 VAC control voltage source used for interlocking.

C. Conductor and Cable Markers:

1. Apply all conductor and cable markers to termination.
2. Heat-shrinkable Tubing:
    a. Tubing shall be shrunk using a heat fun that produces low-temperature heated air.
    b. Tubing shall be tight on the wire after it has been heated.
    c. Characters shall face the open panel and shall read from left to right, or top to bottom.
    d. Marker shall start within 1/32 inch of the end of the stripped insulation point.

D. Conduit Markers:

1. Provide and install conduit markers for every conduit in the electrical system that is identified in the conduit schedule or part of the process system.
2. Conduits shall be marked at the following locations:
    a. Each end of conduits that are greater than 10 feet in length.
    b. Where the conduit penetrates a wall or structure.
    c. Where the conduit emerges from the ground, slab, etc.
    d. The middle of conduits that are ten feet or less in length.
3. Conduits shall be marked after the conduits have been fully painted.
4. Conduit markers shall be positioned so that they are easily read from the floor.
5. Secure all conduit markers with nylon cable ties:
    a. Conduit markers exposed to direct sunlight shall be secured with ultraviolet resistant cable ties.
6. Conduits shall be marked before construction review by Engineer for punch list purposes.
7. Intrinsically safe conduits shall be labeled in accordance with the requirements of the National Electrical Code (NEC).

E. Medium Voltage Raceway Labels:

1. Apply at 50-foot intervals stating the voltage level contained within the raceway.

3.2 FIELD QUALITY CONTROL

A. Replace any nameplates, signs, conductor markers, cable markers or raceway labels that in the sole opinion of the Engineer do not meet the Engineer's aesthetic requirements.

END OF SECTION

SECTION 26 05 73
POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 SUMMARY

A. This Section includes computer-based, fault-current, overcurrent protective device coordination, and arc flash studies. Protective devices shall be set based on results of the protective device coordination study.
   1. Series-rating of devices is not permitted.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For the Power System Study specialist.

D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed.
   1. Input data, including completed computer program input data sheets.
   2. Fault Current Study and Equipment Evaluation Reports.
   3. Coordination-Study Report.
   4. Arc Flash Study Report.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
   1. Professional Engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of Engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 1584 for Arc Flash Study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Computer software shall be SKM Power Tools for Windows or EasyPower.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
   1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:
   1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Impedance of utility service entrance.
   3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
      a. Circuit-breaker and fuse-current ratings and types.
      b. Relays and associated power and current transformer ratings and ratios.
      c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
      d. Generator kilovolt amperes, size, voltage, and source impedance.
      e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
      f. Busway ampacity and impedance.
      g. Motor horsepower and code letter designation according to NEMA MG 1.
   4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
      a. Special load considerations, including starting inrush currents and frequent starting and stopping.
      b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
d. Generator thermal-damage curve.
e. Ratings, types, and settings of utility company's overcurrent protective devices.
f. Special overcurrent protective device settings or types stipulated by utility company.
g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
1. Switchgear and switchboard bus.
2. Motor-control center.
3. Distribution panelboard.
4. Branch circuit panelboard.
5. Transfer switches
6. Equipment control panels.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with applicable IEEE sections.
1. Transformers:
a. ANSI C57.12.10.
b. ANSI C57.12.22.
c. ANSI C57.12.40.
d. IEEE C57.12.00.
e. IEEE C57.96.
2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
3. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:
1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:
1. Device shall not operate in response to the following:
a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
a. Device tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
    a. Device tag.
    b. Voltage and current ratio for curves.
    c. Three-phase and single-phase damage points for each transformer.
    d. No damage, melting, and clearing curves for fuses.
    e. Cable damage curves.
    f. Transformer inrush points.
    g. Maximum fault-current cutoff point.
    h. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH STUDY

A. Perform arc flash study using approved computer software program. Prepare a written report using results of fault-current study and in conjunction with protective device coordination study.

B. Arc flash study should be performed using IEEE1584 equations and NFPA 70E-2018 Standard.

C. Incident energy and arc flash hazard boundary shall be calculated at all significant locations in the electrical distribution system (all switchboards, panelboards, motor control centers, and 3-phase industrial control panels).

D. Calculations should be based on the worst case of all available sources.

E. Calculations should be based on actual overcurrent protective device clearing time, with a maximum arc fault clearing time of 2 seconds.

F. Calculations should be based on results of overcurrent protective device coordination study recommended settings.

G. Arc Flash Study Report: Prepare a written report indicating the following results of the arc flash study:
    1. Tabular Format for each bus:
        a. Arc fault current.
        b. Overcurrent protective device clearing time.
        c. Calculated incident energy at the working distance.
        d. Arc flash protection boundary.

H. Arc Flash Labels shall be provided for installation by the Contractor. Labels should meet the following Standards and requirements:
    1. UL 969 – Standard for Marking and Labeling Systems.
    2. ANSI Z535.4 – Product Safety Signs and Labels.
    3. Labels should include the following information:
        a. System Voltage.

b. Equipment Name and Upstream Protective Device.
c. Arc Flash Protection Boundary.
d. Working Distance.
e. Arc Flash Incident Energy.
f. Recommended PPE based on NFPA 70E-2018 Annex H.
g. Limited and Restricted approach Shock Hazard Boundaries.
h. Date study was performed.

4. Labels should be printed by thermal transfer type printer, with no field markings.

END OF SECTION

SECTION 26 05 83
WIRING CONNECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

A. ASTM International.

B. Code of Federal Regulations.

C. International Electrical Testing Association, NETA.

D. National Electrical Manufactures Association.

E. NFPA 70, National Electrical Code.

F. Underwriters Laboratories Inc.

1.3 SUMMARY

A. Section Includes:
   1. Wiring connecting devices.
   2. Terminations.
   3. Splices.

B. Related Sections:
   1. Contract Documents are a single integrated document, and as such all divisions and sections apply. It is the responsibility of the CONTRACTOR and its Sub-contractors to review all sections to ensure a complete and coordinated project.

1.4 DEFINITIONS

A. Definitions of terms are specified in Section 26 00 00.

1.5 SYSTEM DESCRIPTION

A. Provide a complete system of wiring connectors, terminators, fittings, etc. for a complete wiring system suitable for the cables and conductors used.

1.6 SUBMITTALS

A. Furnish complete submittals in accordance with Section 26 00 00.

B. Product Data:
   1. Catalog cut sheets.

C. Shop drawings:
   1. Drawings showing the installation of junction modules, splices and terminators.

D. Instruction and Operating Manuals:
   1. Include drawings and data for medium voltage cable connectors, splices and junction modules in the operating manuals.

1.7 QUALITY ASSURANCE

A. As specified in Section 26 00 00.

B. All materials shall be UL listed.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Control Connections:
   1. Use insulated ring type wire terminators for connections to all screw terminals:
      a. With chamfered/funneled terminal barrel entry.
      b. Deep internal serrations.
      c. Long barrel design to reduce electrical resistance and increased insulator- barrel surface area to ensure that the insulator remains in contact with the barrel.
      d. Electroplated-tin copper conductor.
      e. Manufactured by the following or equal:
         1) Thomas and Betts, Stakon.
   2. For process equipment connections work from manufacturer's drawings.

B. Joints, Splices, Taps, and Connections:
   1. For 600-volt conductors use solderless connectors.
   2. Use only plated copper alloy connectors or lugs:
      a. Aluminum connectors or lugs are not acceptable for copper conductors.
   3. Under those specific conditions where aluminum conductors have been allowed or are specified then the connectors for aluminum conductors shall be specifically designed for that purpose.
   4. For wire Number 10 AWG and smaller use compression splice caps, with insulating caps.
      a. Manufactured by the following or equal:
         1) Buchanan 2006S or 2011S with 2007 or 2014 insulating caps.
   5. For wire Number 8 AWG and larger, use heavy duty copper compression connectors:
      a. Manufactured by one of the following or equal:
         1) Burndy.
         2) Thomas and Betts.
   6. Where waterproof splices are required:

a. Suitable for indoor, outdoor, weather exposed, direct buried or submersed applications.
b. Utilizing an epoxy, polyurethane, and re-enterable compounds.
c. For use with shielded or unshielded plastic- and rubber-jacketed, signal, control, and power cables rated up to 1 kV.
d. Two-part mold body with tongue and groove seams and built in spacer webbing.
e. Manufactured by the following or equal:
1) 3M – Scotchcast 72-N

7. Optical Fiber terminations:
a. All multimode optical fiber cable installed shall be terminated with a split-ferrule alignment sleeve and a precision ceramic tip. All multimode optical fiber connectors shall meet the following technical specifications:
1) Connector Type: ST
2) Fiber Outside Diameter: 125 microns Nominal
3) Loss Repeat: < 0.2 dB per 100 reconnects
4) Axial Load Minimum: 35 Pounds
5) Temperature Stability: +0.1 dB Maximum from -40°C to 75°C
b. All single mode optical fiber cable installed shall be terminated utilizing a split-ferrule alignment sleeve and a precision ceramic tip. All single mode connectors shall meet the following technical specifications:
1) Connector Type: SC
2) Fiber Outside Diameter 125 Microns
3) Loss Repeat: < 0.2 dB per 1000 reconnects
4) Axial Load, min. 30 pounds
5) Temperature Stability: -40°C to 85°C
c. Contractor shall provide multimode optical fiber patch cords. The multimode optical fiber patch cords shall be Lucent Technologies ML2SC-SC-XX, and shall meet the following technical specifications:
1) Number of fibers: 2
2) Approximate loss, mean, variance 0.1, 0.1
3) Minimum bandwidth: 160 MHz-km @ 850 nm
d. Contractor shall provide single mode optical fiber patch cords. The single mode optical fiber patch cords shall be Lucent Technologies MS2SC-SC-XX, and shall meet the following technical specifications:
1) Number of fibers 2
2) Approximate Loss, mean, variance 0.1dB, 0.7dB

C. Insulating Tape:
1. General purpose insulating tape:
a. Minimum 7 mil vinyl tape.
b. Suitable for application in an ambient of -18°C
c. (0°F).
d. Operating range up to 105°C (220°F).
e. Flame retardant, hot- and cold- weather resistant, UV resistant.
f. For use as a primary insulation for wire cable splices up to 600 VAC.
g. Meeting and complying with:
1) ASTM D-3005 Type I
2) UL 510

3) CSA C22.2

h. Manufactured by the following or equal:
1) 3M – Scotch Number Super 33+.

2. General-purpose color-coding tape:
a. Minimum 7 mil vinyl tape.
b. Suitable for application on PVC and polyethylene jacketed cables.
c. For use indoors and outdoors in weather protected enclosures.
d. Available with the following colors;
1) Red.
2) Yellow.
3) Blue.
4) Brown.
5) Gray.
6) White.
7) Green.
8) Orange.
9) Violet.
e. For use as phase identification, marking, insulating, and harnessing.
f. Meeting and complying with:
1) UL 510.
2) CSA C22.2
g. Manufactured by the following or equal:
1) 3M – Scotch Number 35.

3. Fire and Electric Arc Proofing tape:
a. Minimum 30-mil, flexible, elastomer tape that expands in fire to form an insulating firewall between flame and cable.
b. Bind in place with glass cloth electrical tape.
c. Manufactured by the following or equal:
1) 3M – Scotch Number 77.

4. Glass cloth electrical tape:
a. 7.4-mil thermosetting silicone adhesive that performs at Class H temperatures 180°C (356°F).
b. Use for the following applications:
1) To secure no-PSA insulations such as glass in high-temperature areas.
2) Splice wire rated at 180°C (356°F).
3) For binding Fire and Electric Arc Proofing Tape.
c. Meeting and complying with:
1) MIL-I-1966C.
2) UL Recognized Component listing for 200°C (392°F) (Guide OANZ2, File E17385).
3) CSA Accepted Component 180°C (356°F) File LR93411.
d. Manufactured by the following or equal.
1) 3M – Scotch Number 69.

5. Self-fusing Silicone Rubber Tape:
a. 12-mil, high-temperature, track resistant, insulating tape.
b. Composed of fully cured inorganic silicone rubber.
c. Use as a protective overwrap for terminating medium voltage cables.
d. Manufactured by the following or equal:
1) 3M – Scotch Number 70.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Load connections:
   1. Connect loads to the circuits as indicated. Color-code all branch circuits as per Section 26 05 53 "Electrical Identification."

B. Zero to 600-volt systems:
   1. Make all connections with the proper tool and die as specified by the device manufacturer.
   2. Use only tooling and dies manufactured by the device manufacturer.
   3. Insulate all connections and splices with Scotch 33+ tape and Scotchfill, or pre-molded plastic covers, or heat shrink tubing and caps.
   4. Number all power and control wires before termination.

C. Motor connections (600 Volts and below):
   1. Terminate wires with compression type ring lugs at motors.
   2. Connection at both the motor leads and the machine wires are to have ring type compression lugs.
   3. Cover bolted connectors with a heat shrinkable, cross-linked polyolefin material formed as a single opening boot:
      a. In damp and wet locations use a complete kit containing mastic that shall seal out moisture and contamination.
      b. Shrink cap with low heat as recommended by manufacturer.
   4. Wire markers shall be readable after boot installation.
   5. Manufactured by one of the following or equal:
      a. Raychem MCK.

END OF SECTION

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SECTION 26 08 00
FIELD ELECTRICAL ACCEPTANCE TESTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for testing the electrical system.
   2. Adjusting and calibration.
   3. Acceptance Tests.

B. Related Sections:
   1. The Contract Documents are a single integrated document, and as such all divisions and sections apply. It is the responsibility of the Contractor and its subcontractors to review all sections to ensure a complete and coordinated project.

C. Copyright information:
   1. Some portions of this Specification are copyrighted by the International Electrical Testing Association Incorporated, (NETA). See NETA publication ATS-2017 for details.

1.2 REFERENCES:

A. International Electrical Testing Association Incorporated:

B. Manufacturer's testing recommendations and instruction manuals

C. Specifications sections for the electrical equipment being tested.

D. Submitted seismic calculations and installation details.

1.3 DEFINITIONS

A. Definitions of terms are specified in Section 26 00 00 and noted herein.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Switchgear and Switchboard:
   1. Visual and Mechanical Inspection:
      a. Compare equipment nameplate data with the Drawings and Specifications.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage, alignment, grounding and required clearances.

d. Inspect equipment for cleanliness.
e. Verify that circuit breaker/fuse sizes and types correspond to the approved submittals.
f. Verify that current and voltage transformer ratios correspond to the Drawings.
g. Inspect bolted connections by the following methods.
    1) Calibrated torque wrench.
        a) Refer to manufacturer's instructions of r proper foot-pound levels or NETA ATS-2017.
    2) Thermographic survey.
h. Mechanical and Electrical interlocks:
    1) Attempt closure on locked-open devices.
    2) Attempt to open locked-closed devices.
    3) Make/attempt key-exchanges in all positions.
i. Lubrication requirements.
    1) Verify appropriate lubrication on moving current-carrying parts.
    2) Verify appropriate lubrication on moving and sliding surfaces.
j. Inspect insulators for evidence of physical damage or contaminated surfaces.
k. Verify correct barrier and shutter installation and operation.
l. Exercise all active components.
m. Inspect all indicating devices for correct operation.
n. Verify that filters are in place and/or vents are clear.
o. Perform visual and mechanical inspection of instrument transformers as specified below.
p. Inspect control power transformers.
    1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
    2) Verify that primary and secondary fuse ratings match the submittal drawings.
    3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

2. Electrical Tests.
    a. Perform electrical tests on instrument transformers as specified below.
    b. Perform ground-resistance measurements through bolted connections with a low-resistance ohmmeter if applicable.
    c. Perform resistance measurements through bolted connections with a low-resistance ohmmeter if applicable.
    d. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground for one minute.
    e. Perform an overpotential test on each bus section, each phase to ground with phases not under test grounded, in accordance with manufacturer's published data or NETA ATS-2017. Apply the test voltage for one minute.
    f. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Apply the test voltage for one minute.
    g. Perform system function tests.

h. Perform current injection tests on the entire current circuit of each switchgear or switchboard:
    1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 ampere flows in the secondary circuit:
        a) Verify the correct magnitude of current at each device in the circuit.
    2) Perform current tests by primary injection with magnitudes such that a minimum current of 1.0 ampere flows in secondary circuit:
        a) Verify the correct magnitude of current at each device in the circuit.
i. Determine the accuracy of all meters.
j. Perform phasing check on double-ended or dual-source equipment to ensure correct bus phasing from each source.
k. Control power transformers:
    1) Perform insulation resistance tests, winding-to-winding and winding-to-ground.
        a) Test voltages shall be in accordance with NETA ATS-2017 or as specified by the manufacturer.
    2) Perform secondary wiring integrity test:
        a) Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source:
            i. Verify correct potential at all devices.
    3) Verify correct secondary voltage by energizing primary winding with system voltage.
        a) Measure secondary voltage with the secondary wiring disconnected.
l. Verify operation of space heaters.

3. Test values:
    a. Compare bus connection resistances to values of similar connections.
    b. Bolt-torque levels should be in accordance with NETA ATS-2017 or manufacturer's specifications.
    c. Microhm of millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
        1) If manufacturer's data is not available, investigate any values which deviate from a similar bus by more than 50 percent of the lowest value.
        2) Insulation-resistance values for bus and control power transformers shall be in accordance with manufacturer's published data:
            a) If manufacturer's data is not available refer to NETA ATS-2017.
            b) Investigate insulation values less than the allowable minimum
            c) Do not proceed with overpotential tests until insulation-resistance values are above minimum values.
    d. Bus insulation shall withstand the overpotential test voltage applied.
    e. Insulation-resistance values for control wiring shall be a minimum of 2.0 megohms.

B. Dry Type Transformers:
    1. Visual and Mechanical Inspection.

a. Compare equipment nameplate data with the Drawings and Specifications.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding and required clearances.
d. Inspect equipment for cleanliness.
e. Verify that resilient mounts are free and that any shipping brackets have been removed.
f. Inspect bolted connections by the following methods.
1) Calibrated torque wrench.
a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS-2017.
2) Thermographic survey.
g. Verify that as-lift tap connections are as specified.

2. Electrical Tests:
a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter if applicable.
b. Perform insulation-resistance tests winding-to-winding and each winding-to- ground:
1) Minimum test voltage shall be 1000 volts dc for 600 volt insulation.
2) Calculate dielectric absorption ration or polarization index.
c. Perform turns ratio tests at all tap positions.

3. Test Values:
a. Bolt-torque levels should be in accordance with NETA ATS-2017 or manufacturer's specifications.
b. Microhm of millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
1) If manufacturer's data is not available, investigate any values which deviate from similar connection by more than 50 percent of the lowest value.
c. Insulation-resistance values at one minute should be:
1) 600 volt insulation: 100 megohms.
d. The dielectric absorption ratio or polarization ratio shall be 1.0 or greater.
e. Turns-ratio results should not deviate more than one-half percent from either the adjacent coils or calculated ratio.

C. Cables, 600 volts and less:

1. Visual and Mechanical inspection:
a. Compare cable data with the Drawings and Specifications.
b. Inspect exposed sections of cables for physical damage and correct connection in accordance with the Drawings.
c. Inspect bolted electrical connections for high resistance by the following methods:
1) Calibrated torque wrench.
2) Thermograph survey.
d. Inspect compression-applied connectors for correct cable match and indentation.
e. Inspect for correct identification and arrangements.
f. Inspect jacket insulation and condition.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with low-resistance ohmmeter as specified above.
b. Perform insulation-resistance tests on each conductor with respect to round and adjacent conductors:
1) Applied voltage shall be:
a) 500 volts dc for 300 volt rated cable.
b) 1000 volts dc for 600 volt rated cable.
2) Test duration shall be one minute.
c. Perform continuity tests to ensure correct cable connection.
d. Verify uniform resistance of parallel conductors.

3. Test Values:
a. Compare bolted connection resistances to values of similar connections.
b. Bolt-torque level should be in accordance with NETA ATS-2017
c. Microhm of millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
1) If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.
d. Insulation-resistance values should not be less than 50 megohms.
e. Investigate deviations.

D. Low Voltage Molded Case and Insulated Case Circuit Breakers:
1. Visual and Mechanical Inspection:
a. Compare equipment nameplate data with Drawings and Specifications.
b. Inspect physical and mechanical condition.
c. Inspect anchorage and alignment.
d. Circuit breaker shall be checked for proper mounting, conductor size and feeder designation.
e. Operate circuit breaker to ensure smooth operation.
f. Check tightness of connection with torque wrench in accordance with manufacturer's recommendations.
g. Inspect operating mechanism, contacts, and arc chutes in unsealed units.

2. Electrical tests breakers in excess of 200 Amp trip ratings:
a. Perform resistance measurements through bolted connections with a low resistance ohmmeter.
b. Time-current characteristic tests shall be performed by passing 300 percent rated current through each pole separately. Trip time shall be determined:
1) Determine long-time pickup.
2) Determine short-time pickup.
c. Instantaneous pickup current shall be determined by run-or pulse method:
1) Clearing times should be within 4 cycles or less.
d. Insulation resistance shall be determined pole to pole, across pole and pole to ground.
1) Circuit breaker shall be closed.
2) Test voltage shall be 1000 volts dc applied for one minute.
e. Perform adjustments for final setting in accordance with the Short Circuit and Coordination Study.

3. Test values:
a. Contact resistance shall be compared to adjacent poles and similar breakers:

1) Deviations of more than 50 percent shall be investigated.

b. Insulation resistance shall not be less than 100 megohms.

c. All trip times shall fall within manufacturer's published time current curves:

1) Circuit breakers exceeding maximum time shall be replaced.

d. Instantaneous pickup current levels should be within 20 percent of manufacturer's published values.

E. Grounding Systems:

1. Visual and mechanical inspection:

a. Inspect ground system for compliance with Drawings and Specifications.

b. Inspect physical and mechanical condition.

c. Inspect anchorage.

2. Electrical tests:

a. Perform fall of potential test per IEEE Standard No. 81, Section 8.2.5 on the main grounding electrode or system.

b. Perform ground continuity test between main ground system and all major electrical equipment frames, the system neutral and any derived neutral points:

1) The test shall be made by passing a minimum of 10 amperes D.C. current between ground reference system and the ground point to be tested.

2) Voltage drop shall be measured and resistance calculated by voltage drop method.

3. Test values:

a. The main ground electrode system resistance to ground should be no greater than 5 ohms for commercial or industrial systems and 1 ohm or less for generating or transmission station ground unless otherwise specified by the Engineer.

b. Investigate point-to-point resistance values that exceed 0.5 ohm.

F. Rotating Machinery:

1. Visual and mechanical inspection:

a. Compare equipment nameplate information with the Drawings and Specifications.

b. Inspect physical and mechanical condition.

c. Inspect for proper anchorage, alignment, and grounding.

d. Inspect air baffles, filter media, cooling fans, slip rings, brushes and brush rigging.

e. Inspected bolted electrical connections for high resistance by one of the following:

1) Use of low resistance ohmmeter.

2) Calibrated torque wrench.

3) Thermographic survey.

f. Verify correct application of appropriate lubrication and lubrication systems.

g. Verify the absence of unusual mechanical or electrical noise or signs of overheating during initial test run.

h. Verify that resistance temperature detector (RTD) circuits conform to the Drawings.

i. Verify that metering or relaying devices utilizing RTD's have the correct rating.
j. Special tests as suggested by manufacturer, such as gap spacing and pedestal alignment shall be made where applicable.

2. Electrical tests:
3. Perform resistance measurements through bolted connections with a low resistance ohmmeter.
4. Perform insulation resistance test in accordance with ANSI/EEE43. Test voltage shall be as specified by the manufacturer:
   a. On motors 200 HP and smaller, test duration shall be one minute. Calculate dielectric absorption ratio using resistance measurements at 20 seconds and 60 seconds.
   b. On motors larger than 200 HP, test duration shall be 10 minutes. Calculate polarization index using resistance measurements at one minute and 10 minutes.
   c. Perform dc overpotential tests on motors rated at 1000 horsepower and greater and 4000 volts and greater in accordance with ANIS/EEEE95.
   d. Perform stator resistance test phase-to-phase.
   e. Perform insulation power-factor or dissipation-factor tests.
   f. Perform surge comparison tests.
   g. Perform resistance tests on RTD's.
   h. Verify operation of motor space heater.
   i. Perform a rotation test to ensure correct shaft direction.
   j. Measure no load and full load running current and compare to nameplate.
   k. Observe proper operation and sequence of any reduced voltage starters.
   l. Perform vibration base line test on motors larger than 200 horsepower. Amplitude to be plotted vs. frequency.
   m. Perform vibration amplitude test on motors 200 HP and smaller.
   n. Check all protective devices in accordance with other sections of these specifications.
   o. After start-up of each motor, the current on each phase shall be measured:
      1) At no load.
      2) At defined load:
         a) Record the voltage of each phase to round during this test.
      3) Inrush current.
   p. Measurements shall be recorded on copies on Form 16 B, contained in this Section.
5. Test Values:
   a. Insulation resistance should be not less than 10 megohms.
   b. Dielectric absorption ratio or polarization index readings less than the manufacturer's recommended values (not less than three for polarization index or 1.4 for dielectric absorption ratio) shall be investigated.
   c. Motor measured full load current shall not exceed nameplate value.
   d. Vibration amplitudes shall not exceed values furnished by manufacturer.

G. Motor Control:
1. Visual and Mechanical Inspection:
   a. Compare equipment nameplate data with Drawings and Specifications.
   b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, and grounding.
d. Verify the unit is clean.
e. Verify contactors:
1) Verify mechanical operation.
2) Inspect contact gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.
f. Inspect bolted electrical connections for high resistance using one of the following methods:
1) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 100.12.
g. Perform thermographic survey in accordance with Section 9.
h. Lubrication requirements:
1) Verify appropriate lubrication on moving current-carrying parts.
2) Verify appropriate lubrication on moving and sliding surfaces.

2. Electrical Tests:
a. Perform resistance measurements through bolted connections with a low-voltage resistance ohmmeter, if applicable, in accordance with Section 7.16.1.1.1
b. Perform insulation-resistance tests on each pole, phase-to-phase and phase-to-ground with starter closed and across each open pole for one minute. Test voltage shall be in accordance with manufacturer's published data or Table 100.1.
c. Measure insulation resistance of each control circuit-to-ground.
d. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute. For units with solid-state components, follow manufacturer's recommendation.
e. Test motor protection devices in accordance with manufacturer's published data.
f. Test circuit breakers in accordance with Section7.6.
g. Perform operational tests by initiating control devices.

3. Test Values:
a. Compare bolted connection resistance to values of similar connections.
b. Bolt-torque levels should be in accordance with Table 100.12 unless otherwise specified by manufacturer.
c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.
d. Insulation-resistance values shall be in accordance with Table 100.1.
e. Insulation-resistance values for control wiring shall be a minimum of 2.0 megohms.
f. Motor protection parameters shall be in accordance with manufacturer's published data.

H. Motor Control, Motor Control Centers, Low Voltage:
1. Test the motor control center bus in accordance with the requirements set forth.
2. Test the motor control center bus in accordance with the requirements set forth.

3. Test the motor control center circuit breakers in accordance with the requirements set forth.
4. Test the motor control centers starters in accordance with the requirements set forth.

I. Adjustable speed drive systems:
   1. Visual and mechanical inspection:
      a. Compare equipment nameplate data with Drawings and Specifications.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage, alignment, and grounding.
      d. Verify the unit is clean.
      e. Ensure vent path openings are free from debris and that heat transfer surfaces are clean.
      f. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
      g. Motor running protection:
         1) Verify drive overcurrent setpoints are correct for their application.
         2) If drive is used to operate multiple motors, verify individual overload element ratings are correct for their application.
         3) Apply minimum and maximum speed setpoints. Verify setpoints are within limitations of the load coupled to the motor.
      h. Inspect bolted electrical connections for high resistance using one of the following methods.
         1) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 100.12.
   2. Electrical Tests:
      a. Perform resistance measurements through bolted connections with low-resistance ohmmeter, if applicable, in accordance with Section 7.17.1.
      b. Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.
      c. Test input circuit breaker by primary injection in accordance with Section 7.6.
      d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute. For units with solid-state components, follow manufacturer's recommendation.
      e. Test for the following parameters in accordance with relay calibration procedures outlined in Section 7.9 as recommended by the manufacturer:
         1) Input phase loss protection (Section7.9.3.10).
         2) Input overvoltage protection (Section7.9.3.16).
         3) Output phase rotation (Section7.9.3.10).
         4) Overtemperature protection (Section 7.9.3.11).
         5) DC overvoltage protection (Section 7.9.3.16).
         6) Overfrequency protection (Section 7.9.3.22).
         7) Drive overload protection (Section 7.9.3.14 or 7.6.1.1).
         8) Fault alarm outputs (Section 7.9.3 or 7.9.4).
         9) Slowly vary drive speed between minimum and maximum. Observe motor and load for unusual noise or vibration.
         10) Verify operation of drive from remote start/stop and speed control signals.

3. Test Values:
    a. Compare bolted connection resistance to values of similar connections.
    b. Bolt-torque levels should be in accordance with Table 100.12 unless otherwise specified by the manufacturer.
    c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
    d. Overload test trip times at 300 percent of overload element rating shall be in accordance with manufacturer's published time-current curve.
    e. Insulation-resistance values for control wiring shall be a minimum of 2.0 megohms.
4. Surge Arresters, Low-Voltage Surge Protection Devises:
    a. Visual and Mechanical inspection:
        1) Compare equipment nameplate data with Drawings and Specifications.
        2) Inspect physical and mechanical condition.
        3) Inspect anchorage, alignment, grounding, and clearances.
        4) Verify the arresters are clean.
        5) Inspect bolted electrical connections for high resistance using one of the following methods:
            a) Use of low-resistance ohmmeter in accordance with Section 7.19.2.1.
            b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 100.12.
        6) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
        7) Verify that stroke counter is correctly mounted and electrically connected, if applicable.
        8) Record stroke counter reading.
5. Electrical Test:
    a. Perform resistance measurements through bolted connections with a low resistance ohmmeter, if applicable, in accordance with Section 7.19.2.1.
    b. Perform an insulation-resistance test at voltage levels in accordance with Table 100.1.
    c. Test grounding connection in accordance with Section 7.13.
    d. Perform a watts-loss test.

J. Emergency systems, engine generator and paralleling gear:
1. Visual and Mechanical inspection:
    a. Compare equipment nameplate data with Drawings and Specification.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Verify the unit is clean.
2. Electrical and Mechanical Tests:
    a. Test generator in accordance with Section 7.15.
    b. Test protective relay devices in accordance with Section 7.9.

c. Perform phase-rotation test to determine compatibility with load requirements.
d. Functionally test engine shutdown for low pressure, overtemperature, overspeed, and other protection features as applicable.
e. Perform vibration test for each main bearing cap.
f. Conduct performance test in accordance with ANSI/NFPA 110.
g. Verify correct functioning of governor and regulator.

3. Test Values
a. Phasing shall meet the requirements of the connected load.
b. Vibration levels shall be in accordance with manufacturer's published data.
c. Performance tests shall conform to manufacturer's published data and ANSI/NFPA 100.

K. Fiber-Optic cables:
1. Visual and Mechanical Inspection:
a. Compare cable, connector, and splice data with Drawings and Specification.
b. Inspect cable and connections for physical and mechanical damage.
c. Verify that all connectors and splices are correctly installed.
2. Electrical Tests:
a. Perform cable length measurement, fiber fracture inspection, and construction defect inspection using an optical time domain reflectometer.
b. Perform connector and splice integrity test using an optical time domain reflectometer.
c. Perform cable attenuation loss measurement with an optical power loss test set.
d. Perform connector and splice attenuation loss measurement from both ends of the optical cable with an optical power loss test set.
3. Test Values:
a. The optical time domain reflector signal should be analyzed for excessive connection, splice, or cable backscatter by viewing the reflected power/distance graph.
b. Attenuation loss measurement shall be expressed in dB/km. Losses shall be within the manufacturer's recommendations when no local site specifications are available.

L. Fiber and LAN Testing:
1. General:
a. Conduct test of the fiber optic system in accordance with these special provisions. All test results are to meet or exceed manufacturer specifications. Any fiber that does not meet or exceed manufacturer specifications will be replaced at the Contractor's expense. Tests are to be performed on each cable, and to be tested for breaks, abnormalities, and overall attenuation characteristics.
b. Before conducting any tests, the Contractor shall provide the Engineer with detailed descriptions of test procedures for review and approval. Pre-installation tests and post-installation tests to be witnessed and signed off by Engineer and Owner.
c. The Contractor will provide the Engineer with a copy of the manufacturer's test procedures and quality assurance procedures for information. If the

Engineer determines that these procedures are not adequate, the Engineer may require that additional tests be conducted by the Contractor before installation. Additional testing ordered by the Engineer will be paid for by the Contractor.

d. Perform testing at 4 separate stages:
   1) The Factory.
   2) After delivery but before installation.
   3) After delivery to the job site but before installation.
   4) After installation and as part of final system testing.

e. Provide documentation certifying that the fiber optic cable has passed each testing stage. Provide separate documentation for each testing stage result.

f. Perform attenuation tests with an Optical Loss Test Set capable and calibrated to show anomalies of 0.1 dB as a minimum. Test multimode fibers at 850 nm and 1300 nm. Test single mode fibers at 1310 nm and 1550 nm.

g. OTDR test performed on fiber cables less than 100 meters shall be performed with the aid of a launch cable. OTDR pulse width settings shall be adjusted to a maximum setting of $1/1000^{th}$ of the cable length or 10 nanoseconds.

h. All tests required to ensure the satisfactory installation, adjustment, operation, and performance of all equipment and materials erected and installed under this specification, shall be performed by the Contractor.

i. Furnish all test equipment, meters, instruments and miscellaneous equipment and perform all work required for the tests.

2. Post-installation tests:

   a. For all post-installation tests, the Contractor will notify the Engineer two working weeks in advance. The Contractor will test the fiber optic cable, after installation, to ensure that the fiber has been installed without damage and operates correctly, as follows:

      1) After the fiber optic cable has been pulled, but before breakout and termination, all the fibers shall be tested with an OTDR for fiber integrity as in paragraph above. Copies of traces and test results shall be submitted to the Engineer. If the test results are unsatisfactory, the fiber optic cable segment shall be unacceptable and shall be replaced with a new segment of cable at the Contractor's expense. The new segment of cable shall then be tested to demonstrate acceptability. Copies of the test results shall be submitted to the Engineer.

      2) At the conclusion of all outdoor splices at one location, and before they are enclosed and sealed, all splices at one location, and before they are enclosed and sealed, all splices shall be tested with OTDR at the optimal wavelength (850 and 1300 for multimode, 1310 and 1550 for single mode), in both directions. All tests shall be conducted in the presence of an Engineer and Owner. The splices shall be tested for integrity as well as attenuation. Individual fusion splice losses shall not exceed 0.1 dB. Measurement results shall be recorded, validated by trace, and filled with the recorded, validated by trace, and filled with the records of the respective cable runs. Copies of traces and test results shall be submitted to the Engineer. If the test results are unsatisfactory, the splice shall be unacceptable, and shall be replaced with a new splice at the Contractor's expense. The new splice shall

then be tested to demonstrate acceptability. Copies of the test results shall be submitted to the Engineer.

3) When all fiber links have been completely installed, each link shall be tested with an OTDR and an Optical Loss Test Set. All tests shall be conducted in the presence of the Engineer and Owner. OTDR traces shall be from both directions on each fiber at the 2 optimal wavelengths, 850nm and 1300nm for multimode fibers. Optical loss testing shall be done with handheld tests sets in one direction at the 2 optimal wavelengths for the appropriate fiber type. Copies of traces and test results shall be submitted to the Engineer. If the test results are unsatisfactory, the link shall be unacceptable and shall be corrected to specification at the Contractor's expense. The repaired link shall then be tested to demonstrate acceptability. Copies of the test results shall be submitted to the Engineer. Test equipment shall equal or exceed the accuracy and resolution of Agilent/HP 8147 high performance OTDR.

3. Test Reports:
   a. The Contractor shall furnish the Engineer three copies of all test reports showing the results of all tests specified herein. Test forms shall clearly label the test type, the test location, test date, wavelength, index of refraction, cable identification, fiber type, fiber number, fiber color, and the result of the value of the tested parameter. All OTDR traces shall be supplied on printed hard-copy, and on electronic pdf format. Test reports shall state "PASS" or, "NOT PASSED".
4. LAN Cable Testing:
   a. Testing scope: Test all installed LAN cables.
   b. Test plan and witnessing: Obtain Engineer's approval for the test procedures as part of the submittal process. Arrange for the Engineer to witness all testing. Submit a request for witness 15 days (minimum) before the proposed test date.
   c. Pre-testing:
      1) Test individually cables before installation:
         a) Before physical placement of the cable, the installer shall test each cable while on the spool with a LAN certification test device.
         b) Before the cable is installed, the installer shall check that the cable conforms to the Manufacturer's attenuation specification and that no damage has been done to the cable during shipping or handling.
         c) The test shall be fully documented and the results submitted to the Engineer, including a hard copy of all traces, before placement of the cable.
         d) The Engineer shall be notified if a cable fails to meet specification and the cable shall not be installed unless otherwise directed by the Engineer.
5. Post-testing:
   a. After installing the cable and connectors, test all cables using the LAN certification to confirm the installation meets the requirements of the specification.

b. Provide test documentation that includes the cable number, total length of cable, a permanent hard copy as well as an ASCII-formatted diskette copy of all traces.

c. After installing connectors:

1) Perform cable end-to-end testing on all installed cables from both ends of the cable. Test shall include cable system performance tests and confirm the absence of wiring errors.

2) Submit a signed test report presenting the results of the cable testing.

3) Repair or replace any portions of the system not meeting TIA standards for a Category 5e installation. Repaired sections shall be retested.

4) Submit three copies of all final documentation (including trace), using the approved test form, to the Engineer upon successful completions of the testing.

6. Test Equipment:

a. LAN Certification equipment used for the testing shall be capable of testing Category 6 cable installation to TIA proposed Level III accuracy. Tests performed shall include:

1) Near End Cross Talk.

2) Attenuation.

3) Equal Level Far End Cross Talk.

4) Return Loss.

5) Ambient Noise.

6) Effective Cable Length.

7) Propagation Delay.

8) Continuity/Loop Resistance.

b. LAN certification test equipment shall be able to store and produce plots of the test results.

c. Acceptable Manufacturers:

1) Agilent Technologies, WireScope 350.

2) Or approved equal.

END OF SECTION

SECTION 26 20 00
LOW-VOLTAGE AC INDUCTION MOTORS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. General: The Contractor shall provide electric motors, accessories, and appurtenances, complete and operable, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Bearing Manufacturers Association (ABMA):
   1. ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 – Load Ratings and Fatigue Life for Roller Bearings.

B. Institute of Electrical and Electronic Engineers (IEEE):
   1. IEEE 43 – Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
   2. IEEE 112 – Standard Test procedure for Polyphase Induction Motors and Generators.
   3. IEEE 114 – Standard Test procedure for Single-Phase Induction Motors.
   4. IEEE 303 – Recommended Practice for Auxiliary Devices for Motors in Class 1, Groups A, B, C, and D, Division 2 Locations.
   5. IEEE 841 – Standard for Petroleum and Chemical Industry – Severe Duty totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors – up to and including 500hp.
   6. IEEE 1349 – Guide for the Application of Electric Motors in Class I, Division 2 Hazardous (Classified) Locations.

C. National Electrical Manufacturers' Association (NEMA):
   1. MG-1 – Motors and Generators.
   2. MG-1 – Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators.

D. Underwriters Laboratories Inc. (UL):
   1. UL 674 – Electric Motors and Generators for use in Division 1 Hazardous (Classified) Locations.

1.3 CONTRACTOR SUBMITTALS

A. Complete motor data shall be submitted with the driven machinery shop drawings. Motor data shall include:
   1. Machine name and specification number of driven machine.
   2. Motor manufacturer.
   3. Motor type or model and dimension drawing. Include motor weight.
   4. Nominal horsepower.
   5. NEMA design.
   6. Enclosure.
   7. Frame size.

8. Winding insulation class and temperature rise class.
9. Voltage, phase and frequency ratings.
10. Service factor.
11. Full load current at rated horsepower for application voltage.
12. Full load speed.
13. Guaranteed minimum full load efficiency. Also provide nominal efficiencies at 1/2 and 3/4 load.
14. Type of thermal protection or overtemperature protection, if included.
15. Wiring diagram for devices such as motor leak detection, temperature, or zero speed switches, as applicable.
16. Bearing data. Include recommended lubricants for relubricatable type bearings.
17. If utilized with a variable frequency controller, verify motor is inverter duty type. Include minimum speed at which motor may be operated for the driven machinery.
18. Power factor at 1/2, 3/4 and full load.
19. Recommended size for power factor correction capacitors to improve power factor to 0.95 (lagging) when operated at full load.

B. If water cooling is required for motor thrust bearings, the shop drawing submittals shall indicate this requirement.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of providing full motor load, under the conditions defined in Section 26 00 00.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and handling of motors shall be in accordance with manufacturer's recommendations. Preferred storage is indoors in clean, dry space with uniform temperature to prevent condensation. Protect motors from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.6 QUALITY ASSURANCE

A. All motors shall be UL listed and labeled.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. One of the following or equal:
1. Emerson, US Motors.
2. General Electric.
3. Reliance.
4. Toshiba.
5. Baldor.

2.2 GENERAL REQUIREMENTS

A. Electric motors driving identical machines shall be identical.

B. Maximum motor loading shall in all cases be equal to nameplate horsepower rating or less, exclusive of service factor and as verified with the approved submittal data of the driven machinery.

1. Minimum Motor Horsepower: All motors shall be sized to carry continuously all loads which may be imposed through their full range of operation. The motor horsepower shall be not less than the estimated minimum specified for each driven machine. If the estimated minimum horsepower specified is not adequate to satisfy the foregoing restrictions or any other requirements of these Specifications, the motor with the required horsepower shall be supplied at no additional cost to the Owner. In addition, any changes caused by increase in motor horsepower shall be made by the Contractor at no additional cost to the Owner; such changes may involve circuit breakers, magnetic starters, motor feeder conductors, conduit sizes, etc.
2. Exempt Motors: Motors which are for valve operators, submersible pumps, or motors which are an integral part of Standard Manufactured Equipment, i.e., non-NEMA mounting, common shaft with driven element, part of domestic or commercial use apparatus may be excepted from these Specifications to the extent that such variation reflects a necessary condition of motor service or a requirement of the driven equipment.

2.3 DESIGN REQUIREMENTS

A. General: All electric motors shall comply with ANSI/NEMA MG 1 - Motor and Generator.

B. NEMA Design: Electric motors shall be NEMA Design B, (except as indicated in Equipment Specifications for motors controlled for variable speed operation and other special motors,) constant speed squirrel-cage induction motors having normal starting torque with low starting current. In no case shall starting torque or breakdown torque be less than the value in ANSI/NEMA MG 1. Motors shall be suitable for the starting method indicated on the Electrical Drawings.

C. Motor Voltage Ratings: Motors shall have voltage ratings in accordance with the following, unless otherwise indicated:

1. Voltage:
   a. All motors ½ hp and larger shall be 460V, 3 phase unless otherwise indicated on the Drawings.
   b. dual voltage motors rated 230/460V, 3 phase are acceptable provided all leads are brought to the conduit box.
2. Motors driving identical machines shall be identical.
3. All motors 1 hp and larger shall be “Premium Efficiency” motors as defined in NEMA MG-1.
4. Horsepower as indicated on the Drawings:
   a. Horsepower ratings shown on the drawings are based on Vendor’s estimates. Provide motors sized for the load of the actual equipment furnished.
5. Service Factor:
   a. Provide motors rated at 1.15 Service Factor.

b. Provide motors capable of operating continuously at 1.15 Service Factor at project altitude.
    1) Without exceeding Class B temperature rise limits where motors are provided with Class F insulation.
    2) Without exceeding Class F temperature rise limits where motors are provided with Class H insulation.

6. Torque:
    a. Provide motors that develop sufficient torque for acceleration to full speed at voltage 10 percent less than motor nameplate rating.
    b. When started using reduced voltage starters:
        1) Provide motors that develop sufficient torque for acceleration to full speed.
    c. NEMA Design B except where driven load characteristics require other than normal starting torque.
        1) In No case shall starting torque or breakdown torque be less than the values specified in NEMA MG-1.
7. Enclosures:
    a. As indicated in the individual equipment Specifications or as specified in this section.
    b. Totally Enclosed Fan Cooled::
        1) Cast iron conduit box.
        2) Tapped drain holes with Type 316 stainless steel plugs for frames 286T and smaller, and automatic breather and drain devices for frames 324T and larger.
    c. Explosion-Proof:
        1) Tapped drain holes with corrosion resistant plugs for frames 286T and smaller and automatic breather and drain devices for frames 324T and larger.
    d. Lifting Devices: All motors weighing 265 pounds (120 kilograms) or more shall have suitable lifting devices for installation and removal.
8. Manufactured with cast iron frames in accordance with NEMA MG-1.
9. Nameplates:
    a. Provide all motors with a permanent, stainless steel nameplate indelibly stamped or engraved with:
        1) NEMA Standard motor data.
        2) Bearing description and lubrication instructions.
10. Hardware:
    a. Type 316 stainless steel.
11. Conduit Boxes:
    a. Cast iron or stamped steel.
    b. Split from top to bottom.
    c. Provide gaskets at the following interfaces:
        1) Frames and conduit boxes.
        2) Conduit boxes and box covers.
    d. Rotatable through 360 degrees in 90 degree increments.
    e. Exceeding the dimensions defined in NEMA MG-1.
    f. Provide grounding lugs inside conduit boxes for motor frame grounding.
12. Motor Bearings:
    a. Antifriction.

b. Regreasable and initially filled with grease.
c. Pumps Motor ion excess of 100 HP shall have oil lubricated bearings.
d. Bearings and lubrication suitable for ambient temperature and temperature rise.
e. Suitable for intended application and have ABMA L-10 rating life of 60,000 hours or more.
f. Fit bearings with easily accessible grease/oil supply, flush, drain, and relief fittings using extension tubes where necessary.
g. Where specified in the equipment specifications, provide split-sleeve type hydrohdynamic radial bearings. Provide a bearing isolator to protect bearings from contaminants.

13. Insulation Systems:
    a. Motors Installed in Ambient Temperatures of 40 degrees Celsius or less:
        1) Provide Class F insulation.
        2) Design temperature rise consistent with Class B insulation.
        3) Rated to operate at an ambient temperature of 40 degrees Celsius and at the altitude where the motor will be installed.
    b. Motors Installed in Ambient Temperatures of 40 degrees Celsius and 65 degrees Celsius:
        1) Provide Class H insulation.
        2) Design temperature rise consistent with Class F insulation.
        3) Rated to operate at an ambient temperature of 65 degrees Celsius and at the altitude where the motor will be installed.
14. Motor Leads:
    a. Insulated leads with non-wicking, non-hydroscopic material. Class F insulation.
15. Noise:
    a. Maximum operating noise level of 85dB measured as per IEEE 85.

D. Submersible Motors:
1. Enclosures:
    a. Totally Enclosed Non-Ventilated (TENV) watertight casing.
    b. Smooth outer surface. Cooling fins may clog with solids and are not acceptable.
    c. Inner and outer shaft seals separated by an oil chamber.
2. Cooling:
    a. Suitable continuous operation in totally, partially, or nonsubmerged condition without overheating.
    b. Convection cooling only.
    c. Water jackets and oil cooling are not acceptable.
3. Electrical Cables:
    a. Wire unit without splices. Coordinate with Contractor to ensure cables of adequate length.
    b. Epoxy encapsulated able entry into terminal box.
4. Insulation:
    a. Sealed moisture resistant windings.
5. Motor Protection:
    a. Provide temperature detection in motor windings.
    b. Provide moisture detection in motor housing.

c. Provide associated electronics and relaying in a separate enclosure to be mounted remotely.

E. Vertical Motors:
1. Enclosures:
a. Weather protected Type II (WPII) where installed outdoors.
b. Weather protected Type I (WPII) where installed indoors.
2. Thrust Bearings:
a. Selected for combined rotor and driven equipment loads.
b. Coordinate with driven equipment supplier for maximum vertical thrust of driven equipment.

F. Variable Frequency Drive Motors
1. Compatible with the variable frequency drives specified.
2. Inverter duty rated and labeled.
3. Meet the requirements of NEMA MG-1 Part 31.
4. Winding insulation meets the requirements of NEMA MG-1 Part 31.4.4.2.
5. Capable of running continuously at 1/10th of full speed, with no harmful effects or overheating.
6. Service factor of 1.0 when driven by VFD.

G. Motors Installed in Corrosive Environments:
1. Nameplate indicating conformance to IEEE 841.
2. Stator double dipped in varnish and baked.
3. Stator and rotor coated with corrosion resistant epoxy.
4. Frame, brackets, fan guard and conduit box coated with minimum of two coats of epoxy paint.
5. Withstand salt spray tests as per ASTM B-117.
6. Suitable for hose down areas.

H. Single Phase Motors:
1. Capacitor start type rated for operation at 115 volts, 60 hertz, unless otherwise specified or as indicated on the Drawings.
2. Totally enclosed, fan cooled motors manufactured in accordance with NEMA MG-1.
3. Ball Bearings: Sealed.
4. ½ Horsepower or Less Fan Motors:
a. Split-phase or shaded pole type when standard for the equipment.
b. Open type when suitably protected from moisture, dripping water, and lint accumulation.
5. Wound rotor or commutator type single-phase motors only when their specific characteristics are necessary for application and their use is acceptable to the Engineer.
6. Integral overload protection.

2.4 ACCESSORIES

A. See Drawings for accessories included in pump motor starter wiring diagrams.

B. Contractor responsible to coordinate all accessories specifically required by pump motor supplier for incorporation in motor starter control cabinet whether shown on Drawings or not.

C. Space Heaters:
1. Provide all 3 phase motors with belted or cartridge space heaters mounted within the motor enclosure as indicated on the Drawings and Equipment Specifications
2. Space heater rating shall be 120 volts, single-phase, unless otherwise shown.
3. Power leads for heaters wired into conduit box.
4. Installed within motor enclosure adjacent to core iron.

D. Winding Temperature Detectors:
1. Provide temperature switches with normally closed contacts or resistance temperature detectors, 2 per each phase, as indicated on the Drawings and Equipment Specifications.

E. Bearing Temperature Detectors:
1. Where required by the driven equipment specification or as indicated on the Drawings.
2. RTD type and wiring matches the winding RTDs.

F. Vibration Detectors:
1. Where required by the driven equipment specification or as indicated on the Drawings.
2. In accordance with the driven equipment specification.

2.5 SOURCE QUALITY CONTROL

A. Factory Testing
1. Perform factory tests in accordance with:
a. IEEE 112 for three phase motors.
b. IEEE 114 single phase motors.
2. Furnish copies of test reports.
3. Include testing of:
a. No load current.
b. Locked rotor current.
c. Winding resistance.
d. High potential.
4. Tests required on motors 250 hp and larger:
a. Manufacturer's routine test (use polarization index voltage = 5000V for insulation resistance tests).
b. Efficiency and power factor versus load test performed at rated speed and 50 percent, 75 percent, 90 percent, and 100 percent of rated load. The curves from the motor tests shall be submitted for information.
c. The maximum allowable residual unbalance in each correction plane (journal) shall be calculated using the following equation:
1) U = 4 W/N
2) Where:
3) U = residual correction plane unbalance, in ounces-inches

4) W = static correction plane journal loading, in pounds
5) N = maximum specified operating speed, in revolutions per minute

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install motors in accordance with manufacturer's instructions.

B. Electrical work involving connections, controls, switches, disconnects, etc., shall be performed as provided in the applicable sections of Division 26.

3.2 FIELD QUALITY CONTROL

A. Before start-up perform insulation resistance test on each motor furnished or installed on this project.
1. Windings energized to 1000 volts D.C. for one minute.
2. Resistance measured at the end of the test, recorded, and submitted to the Engineer for review.
3. Inform the Engineer of any unusual or unacceptable test results.

3.3 VISUAL AND MECHANICAL INSPECTION FOR MOTORS AND THEIR ROTATING MACHINERY:

A. Compare equipment nameplate information with the Drawings and Specifications.

B. Inspect physical and mechanical condition.

C. Inspect for proper anchorage, alignment, and grounding.

D. Inspect air baffles, filter media, cooling fans, slip rings, brushes and brush rigging.

E. Inspected bolted electrical connections for high resistance by one of the following:
1. Use of low resistance ohmmeter.
2. Calibrated torque wrench.
3. Thermographic survey.

F. Verify correct application of appropriate lubrication and lubrication systems.

G. Verify the absence of unusual mechanical or electrical noise or signs of overheating during initial test run.

H. Special tests as suggested by manufacturer, such as gap spacing and pedestal alignment shall be made where applicable.

3.4 ELECTRICAL TESTS:

A. Perform resistance measurements through bolted connections with a low resistance ohmmeter.

B. Perform insulation resistance test in accordance with ANSI/IEEE43. Test voltage shall be as specified by the manufacturer:
   1. On motors 200 HP and smaller, test duration shall be one minute. Calculate dielectric absorption ratio using resistance measurements at 20 seconds and 60 seconds.
   2. On motors larger than 200 HP, test duration shall be 10 minutes. Calculate polarization index using resistance measurements at one minute and 10 minutes.
      a. Perform stator resistance test phase-to-phase.
      b. Perform insulation power-factor or dissipation-factor tests.
      c. Perform surge comparison tests.
      d. Verify operation of motor space heater.
      e. Perform a rotation test to ensure correct shaft direction.
      f. Measure no load and full load running current and compare to nameplate.
      g. Observe proper operation and sequence of any reduced voltage starters.
      h. Perform vibration base line test. Amplitude to be plotted vs. frequency.
      i. Check all protective devices in accordance with other sections of these specifications.
      j. After start-up of each motor, the current on each phase shall be measured:
         1) At no load.
         2) At defined load:
         3) Record the voltage of each phase to round during this test.
         4) Inrush current.

C. Measurements shall be recorded and submitted to the Engineer.

3.5 TEST VALUES:

A. Insulation resistance should be not less than 10 megohms.

B. Dielectric absorption ratio or polarization index readings less than the manufacturer's recommended values (not less than three for polarization index or 1.4 for dielectric absorption ratio) shall be investigated.

C. Motor measured full load current shall not exceed nameplate value.

D. Vibration amplitudes shall not exceed values furnished by manufacturer.

END OF SECTION

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MOTOR DATA SHEET

MOTOR NUMBER: _____ MOTOR/EUIPMENT NAME _____

SPECIFICATION NUMBER OF DRIVEN MACHINE _____

MOTOR NAMEPLATE DATA

MANUFACTURER _____ MODEL/SERIES _____ MODEL NO. _____

FRAME		ENCLOSURE		NEMA DESIGN	
HP		SERVICE FACTOR		RPM	
INSULATION CLASS		VOLTS		FULL LOAD AMPS	
AMBIENT TEMP		PHASE		NO LOAD AMPS	
DESIGN TEMP RISE		HERTZ		LOCK ROTOR AMPS	
				INRUSH CODE LETTER	

	100 PERCENT LOAD	75 PERCENT LOAD	50 PERCENT LOAD
GUARANTEED MIN EFFICIENCIES			
GUARANTEED MIN POWER FACTOR			

MAX SIZE OF POWER FACTOR CORRECTION CAPACITOR _____ KVAR

ACCESSORIES

MOTOR WINDING HEATER _____ VOLTS _____ WATTS

WINDING THERMAL PROTECTION _____

WINDING TEMP SWITCHES (YES/NO) _____

RTD TYPE _____ QUALITY PER PHASE _____ # OF WIRES _____

NOMINAL RESISTANCE _____ NOMINAL TEMP _____ COEFFICIENT _____

RECOMMENDED ALARM _____ DEGREES C _____ RECOMMENDED TRIP _____ DEGREES C

SPECIAL APPLICATIONS

INVERTER DUTY* (YES/NO) _____ PART WINDING (YES/NO) _____ WYE-DELTA (YES/NO) _____

2 SPEED, 1 WINDING (YES/NO) _____ 2 SPEED, 2 WINDING (YES/NO) _____

AREA CLASSIFICATIONS

CLASS _____ DIVISION _____ GROUP _____ TEMP CODE _____

* Conforms to NEMA MG-1 Part 31.

SECTION 26 21 00
UTILITY COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
1. Requirements for coordination with the utility companies to provide service.
2. Contractor's responsibilities for connecting to utilities and providing utility service to the facilities.
3. Descriptions of utility services required.

1.2 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
1. National Electrical Code.
2. Institute of Electrical and Electronic Engineers.
3. National Fire Protection Association.

1.3 SYSTEM DESCRIPTION

A. Electrical Service
1. The facility will be served primary power at distribution voltage levels from an underground feeder and metering enclosure owned and furnished by the Electric Utility.
2. The Contractor may be required to install conduit, including trenching, backfill, etc. for primary distribution as indicated on Drawings.
3. The Contractor shall make all necessary arrangements with the electric utility to provide electric service.
4. The Contractor shall provide all work and materials and bear all costs for providing temporary construction power and the permanent electrical service, including but not limited to:
    a. All work and materials not provided by the Utility.
    b. All permits and fees required by the Utility.
5. The Contractor shall provide electrical ducts, raceways, conductors and connections shown on the plans, and all other work and materials required for a complete electrical service, including but not limited to the following:
    a. Electrical service conduits and conductors from the point of utility termination to the service entrance equipment.
    b. Metering conduits from the instrument transformers to the meter.

B. Fiber Optic Service
1. The Contractor shall make all necessary arrangements with the fiber optic service utility to provide fiber optic service.
2. The Contractor shall provide all work and materials and bear all costs for the fiber optic service during construction and the final fiber optic service for the facility, including but not limited to:
    a. All work and materials not provided by the utility.

b. All permits and fees required by the utility.

3. The Contractor shall provide and install the fiber optic entrance conduit from the terminal pole or pedestal to the fiber optic board in the facility, and all other work and materials required for a complete fiber optic service.

1.4 SUBMITTALS

A. Furnish complete submittals in accordance with Section 26 00 00.

B. Certification

1. Submit certification that the intended installation has been coordinated with the utility companies. Certification shall include a narrative description of the utility's requirements and points of connection and names and fiber optic numbers for contacts at the utilities.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements

1. NEC.
2. Local codes.
3. Local utility standards.

1.6 SEQUENCING AND SCHEDULING

A. Prior to submitting any bid, the Electrical Contractor is responsible for contacting the utilities to determine the work and materials that will be required from the Contractor, and all fees and permits that will be required, so that all utility systems furnished by the Contractor will be included in the Contractor's bid.

1. No additional charges will be allowed by the Contractor, due to failure to include such charges in its bid.

B. Prior to start of site work, make arrangements for temporary fiber optic and electrical service as required.

C. Prior to commencing work, coordinate complete electric service entrance requirements with local electric utility to assure that the installation will be complete in accordance with these specifications.

1. Ensure power transformer size, electrical characteristics and location are consistent with the design and service voltage provided by the electrical utility coordinated with other trades.
2. Arrange for electric meter (by Utility) and provide meter bases in accordance with utility requirements.
3. Furnish and coordinate installation of metering C.T.'s and P.T.'s furnished by Utility.
4. Pay any charges required by the electric utility for connection and turn-on.

D. Prior to commencing work, coordinate complete fiber optic service.

1. Verify compliance with fiber optic service utility requirements.
2. Verify exact location of each service point and type of service.
3. Pay any charges required by the fiber optic service utility for connection and turn-on.

E. Coordinate complete fiber optic line connections at locations indicated on Drawings with the local fiber optic company.

F. Prior to commencing site work, coordinate underground conduit installations with other work to eliminate conflicts and avoid interferences with other underground piping systems.

G. Coordinate necessary outages with local utility and Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall be furnished in accordance with the applicable requirements of the utilities and these specifications.

2.2 EQUIPMENT

A. Equipment shall be furnished in accordance with the applicable requirements of the utilities and these specifications.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 26 22 00
DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Enclosed dry type transformers.
      a. Stand-alone units.
      b. Units located in motor control centers.
      c. Units located in packaged power supplies.
   2. Rated 1 to 1,000 KVA.
   3. Primary voltage 600 V and below.

B. Related Sections:
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.2 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. National Electrical Code.
   2. Institute of Electrical and Electronic Engineers.
   3. American National Standards Institute.
   4. National Fire Protection Association.

1.3 SYSTEM DESCRIPTION

A. Provide 3-phase, or 1-phase, 60 hertz, dry type transformers with the voltage ratings, KVA capacities, and connections as indicated on the contract drawings.

B. Overall dimensions not to exceed the limits indicated or the space available.

1.4 SUBMITTALS

A. Furnish complete submittals in accordance with:
   1. Division 26, Section 26 00 00 “Electrical General Provisions.”

B. Product Data
   1. Catalog cut sheets.
   2. Nameplate data.
   3. Weight and overall dimensions.
   4. Inrush current.
   5. Insulation system and temperature constraints.
   6. Number and rating of taps.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements
   1. Meeting all applicable requirements of NEMA ST-20.
   2. Sound levels measured and in accordance with ANSI-C89.
   3. UL 1561.
   4. CSA C22.2.
   5. ANSI/NEMA ST-20-1988.

1.6 PROJECT/SITE CONDITIONS

A. In conformance with the site conditions as identified in Section 26 00 00.

1.7 WARRANTY

A. All transformers shall be fully warranted for a period of two years from the date of substantial completion.

B. In accordance with the requirements of Section 26 00 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers of standard power transformers:
   1. Eaton.
   2. Square D; a brand of Schneider Electric.
   3. Siemens.

2.2 MATERIALS

A. Insulation:
   1. Transformers 25KVA and smaller: 185°C class.
   2. Transformers 30KVA and larger: 220°C class.
   3. Non-flammable.

B. Cores of grain-oriented silicon steel.

C. Windings
   1. High-grade magnet wire.
   2. Clearly marked terminal pads shall be attached to a rugged fiberglass termination strip.
   3. Material:
      a. Copper only.

2.3 EQUIPMENT

A. Ratings
   1. BIL of 10 kv for 600 V class windings.

2. Sound levels, under ANSI Standard test conditions, not to exceed:
   a. 1-9 KVA 40 db.
   b. 10-50 KVA 45 db.
   c. 51-150 KVA 50 db.
   d. 151-300 KVA 55 db.
   e. 301-500 KVA 60 db.
3. Impedance, unless indicated otherwise, within the following ranges:
   a. 75 through 150 KVA, 2.0% to 5.0%.
4. Efficiencies, for full load at 170°C winding temperature, no less than:
   a. 30 through 75 KVA, 97.0%.
   b. Submit test data, if requested, to prove compliance with the above.
5. Daily overload capacities, at rated voltage and without reduction in life, in accordance with the loading guide as published in ANSI C57.96.
6. Temperature Rise
   a. Transformers rated below 15 KVA shall have a maximum temperature rise of 115°C over a 40°C ambient at full load.
   b. Transformers rated 15 KVA and above shall be of a low temperature rise design (temperature rise consistent with the next temperature class below the insulation provided). The temperature rise, over a 40°C ambient at full load, shall not exceed the value shown below for the insulation class provided:

	Insulation Class	Temperature Rise
1)	220°C	115°C
2)	185°C	80°C
3)	150°C	55°C

B. Taps
1. 3 through 25 KVA.
   a. Two 5% taps below normal.
2. 30 KVA and above.
   a. Four full capacity 2.5% primary taps: two above rated voltage, and two below rated voltage.
   b. Operated by a tap changer handle or tap jumpers accessible through a panel.

C. Terminals, suitable for either copper or aluminum conductors, located at the bottom or where the temperature at full load in a 40°C ambient will not exceed 60°C.

D. Enclosures for free-standing transformers.
1. Heavy gauge steel.
2. Indoor: drip-tight.
3. Louvers to limit coil temperature rise to the value stated above, and case temperature rise to 50°C.
4. Finish to consist of de-greasing, phosphate cleaning, and an electrodeposit ANSI 61 gray enamel rust inhibiting paint.
5. Wiring compartment temperature rise less than 35°C.

E. With built-in vibration dampeners to isolate the core and coils from the enclosure.
1. Neoprene vibration pads and sleeves.

F. Nameplates
   1. Provide metal nameplates with stamped or engraved markings showing:
      a. Connections, including taps.
      b. KVA, phases, frequency.
      c. Primary and secondary voltages.
      d. Percent R, X, and Z.
      e. Temperature rise.
      f. Insulation class.
      g. BIL rating.
      h. No load and full load losses.
      i. Sound level rating.

2.4 SOURCE QUALITY CONTROL

A. Tests
   1. Applied voltage test to each winding and from each winding to the core:
      a. 600 V class winding 4 kV.
   2. Induced voltage test at 2 times normal voltage and 2 times the frequency for 7,200 cycles.
   3. Voltage ratio and polarity.
   4. Sound level, performed in a test room with ambient sound level not exceeding 24 db.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor, wall, platform, MCC, packaged power supply, or roof mounted, as indicated.

B. Locate where not in direct contact with building structure.

C. Install on Korfund Series F or H double-deflection mounts, selected for maximum isolation.

D. Make any necessary connections to the enclosure with liquidtight flexible conduit having neoprene gaskets and insulated ground bushings.

E. Ground the enclosure:
   1. To an equipment ground conductor in the conduit.
   2. To the facility ground ring.

F. Install floor-mounted transformers on 3-1/2" housekeeping pads.

3.2 FIELD QUALITY CONTROL

A. Perform acceptance tests in accordance with Section 26 08 00, “Field Electrical Acceptance Tests.”

3.3 ADJUSTING

A. In the presence of the Engineer, provide all meters and manpower to set the transformer taps as directed by the Engineer.

END OF SECTION

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SECTION 26 24 13
SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 SUMMARY

A. Section Includes:
1. Service and distribution switchboards rated 600 V and less.
2. Transient voltage suppression devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.
8. Utility metering.

1.3 PERFORMANCE REQUIREMENTS
1. Seismic Performance: Switchboards shall comply with the applicable seismic requirements.

1.4 SUBMITTALS

A. Product Data:
1. For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include:
a. Dimensions
b. Accessories
c. Finishes
d. Manufacturers' technical data regarding:
1) Features
2) Performance
3) Electrical characteristics
4) Ratings

B. Shop Drawings:
1. For each switchboard and related equipment.
a. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
b. Detail enclosure types for types other than NEMA 250, Type 1.
c. Detail bus configuration, current, and voltage ratings.

d. Detail short-circuit current rating of switchboards and overcurrent protective devices.
e. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
f. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
g. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
h. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Samples:
1. Representative portion of mimic bus with specified material and finish, for color selection.

D. Qualification Data: For qualified installer.

E. Seismic Qualification Certificates:
1. Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand the applicable seismic forces. Include the following:
a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Field Quality-Control Reports:
1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

G. Operation and Maintenance Data:
1. For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified elsewhere, include the following:
a. Routine maintenance requirements for switchboards and all installed components.
b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. An employer of workers qualified as defined in NEMA PB 2.1
2. Trained in electrical safety as required by NFPA 70E.

B. Source Limitations:
1. Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space:
1. Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heaters to prevent condensation.

C. Handle and prepare switchboards for installation according to applicable standards.

1.7 PROJECT CONDITIONS

A. Installation Pathway:
1. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:
1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the installed conditions unless otherwise indicated.

1.8 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

C. Coordinate utility metering switchboards with utility requirements.

1.9 WARRANTY

A. Special Warranty:
   1. Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   2. Warranty period of five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers:
   1. Subject to compliance with requirements, provide products by one of the following:
      a. Eaton.
      b. Square D; a brand of Schneider Electric.
      c. Siemens.

B. Nominal System Voltage: As indicated on drawings.

C. Main-Bus Continuous: As indicated on drawings.

D. Indoor Enclosures: Steel, NEMA 250, Type 1 unless indicated otherwise on drawings.

E. Outdoor Enclosures: Steel, NEMA 250, Type 3R unless indicated otherwise on Drawings.

F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

G. Barriers: Between adjacent switchboard sections.

H. Insulation and isolation for main and vertical buses of feeder sections.

I. Customer Metering Compartment: Where indicated on Drawings a separate customer metering compartment and section with front hinged door, for indicated metering, and

current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.

J. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

K. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

L. Pull Box on Top of Switchboard:
1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Set back from front to clear circuit-breaker removal mechanism.
3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

M. Buses and Connections:
1. Three-phase, four-wire unless otherwise indicated.
2. Phase and Neutral Bus Material: Hard-drawn copper of 98 percent conductivity with tin-plated aluminum or copper feeder circuit-breaker line connections.
3. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated. Equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

N. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

O. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 degrees C.

P. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings where indicated:
    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.
2. GFCI Circuit Breakers: Where indicated, Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
3. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Where indicated Class B ground-fault protection (30-mA trip).
4. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
5. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
6. Ground-Fault Protection: Where indicated, integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
7. Shunt Trip: Where indicated, 120-V trip coil energized from separate circuit.

2.3 INSTRUMENTATION

A. Where shown on Drawings provide metering as follows:

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    a. Phase Currents, Each Phase: ±1%
    b. Phase-to-Phase Voltages, Three Phase: ±1%
    c. Phase-to-Neutral Voltages, Three Phase: ±1%
    d. Megawatts: ±2%
    e. Megavars: ±2%
    f. Power Factor: ±2%
    g. Frequency: ±0.5%
    h. Accumulated Energy, Megawatt Hours: ±2%; accumulated values unaffected by power outages up to 72 hours.
    i. Megawatt Demand: ±2%; demand interval programmable from 5 to 60 minutes.
    j. Demand: Capable of indicating and recording 15-minute demand.
2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Communications: Provide an **ETHERNET/IP** interface allowing meter to be used with an external system within a multi-drop LAN configuration without the use of a gateway.

2.4 CONTROL POWER

A. Control Circuits: 120 VAC, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

2.6 IDENTIFICATION

A. Comply with Section 26 05 53.

2.7 SURGE PROTECTION DEVICE

A. Where indicated on Drawings provide surge protection. See Section 26 43 00 for SPD requirements.

2.8 ACTIVE HARMONIC FILTER

A. Where indicated on Drawings, active harmonic filters are required when switchboards are connected to VFD driven loads. The switchboard supplier shall coordinate with the VFD/Active harmonic filter supplier to appropriately size the circuit breaker to the AHF and all other requirements of the AHF.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to applicable standards.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to manufacturer's recommendations.

B. Equipment Mounting: Install switchboards on concrete bases.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Comply with seismic mounting and anchoring requirements.

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 26 05 53.

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 26 05 53.

C. Device Nameplates: Label each disconnecting device, overcurrent protective device, meter, and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 26 05 53.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform Tests and Inspections:
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   2. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
   3. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:
        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated in the Overcurrent Protective Device Coordination Study.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION

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SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Sections:
   1. Division 26, Section 26 00 00 "Electrical General Provision."

B. Section Includes: Panelboards serving facility feeder circuits or other utilization equipment at the following voltage levels:
   1. 208Y/120 V, 3-phase, 4 wire.
   2. 480Y/277 V, 3-phase, 4 wire.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
   1. IEEE C62.41 – Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

B. National Electrical Manufacturers Association:
   1. NEMA AB 1 – Molded Case Circuit Breakers and Molded Case Switches.
   2. NEMA ICS 2 – Industrial Control and Systems: Controllers, Contractors, and Overload Relays, Rated Not More Than 2000 V AC or 750 V DC.
   3. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum).
   4. NEMA PB 1 – Panelboards.
   5. NEMA PB 1.1 – General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 V or Less.

C. International Electrical Testing Association:
   1. NETA ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

D. National Fire Protection Association:
   1. NFPA 70 – National Electrical Code.

E. Underwriters Laboratories Inc.:
   1. UL 67 – Safety for Panelboards.
   2. UL 1449 – Transient Voltage Surge Suppressors.

1.3 SUBMITTALS

A. Refer to Division 01, Section 01 33 00 "Submittal Procedures."

B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

C. Product Data: Submit catalog data showing specified features of standard products.

1.4 RECORD DOCUMENTS

A. Record actual locations of panelboards and record actual circuiting arrangements in accordance with Division 01, Section 01 78 39 “Project Record Documents.”

B. Operation and Maintenance Data:
   1. Submit spare parts listing.
   2. Source current prices of replacement parts and supplies, and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of experience.

1.6 SYSTEM DESCRIPTION

A. Furnish and install circuit breaker panelboards as indicated in the panelboard schedules, one-lines, and *where indicated on the drawings*:
   1. Service voltage and configuration per the panel schedules.

B. Short circuit rating:
   1. Testing method per UL 67.
   2. Provide panelboards rated as indicated on the drawings.
   3. Mark panelboards with their maximum short circuit rating at the supply voltage.
   4. Panelboards shall be fully rated.

C. Provide panelboards:
   1. With dead front construction.
   2. Equipped with thermal magnetic molded-case circuit breakers and/or solid-state trip circuit breakers, with trip ratings as shown on the panel schedules.
   3. Flush, surface, or motor control center mounted as indicated on the drawings.

D. Provide spares and spaces for future circuit breakers in panels as indicated on the drawings.

1.7 PROJECT/SITE CONDITIONS

A. Refer to Division 26, Section 26 00 00 “Electrical General Provisions.”

1.8 WARRANTY

A. Provide manufacturer’s complete two-year parts and labor warranty, to begin upon final acceptance of the project.

PART 2 - PRODUCTS

2.1 BRANCH CIRCUIT PANELBOARDS

A. Manufacturers:
   1. Subject to compliance with requirements, provide product by one of the following:
      a. Eaton.
      b. Square D; a brand of Schneider Electric.
      c. Siemens.

B. Product Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

C. Bus:
   1. General Bus:
      a. Silver-plated copper
   2. Phase Bus:
      a. Phase busing shall be full size and height, without reduction.
      b. Sized in accordance with UL standards to limit temperature rise on any current carrying part, to a maximum of 50 degrees Celsius:
         1) Limit current density to less than 1,000 A per square inch.
      c. Insulate all current carrying parts from ground and phase-to-phase with a high dielectric strength insulator.
   3. Ground Bus:
      a. Solidly bonded system copper.
   4. Neutral Bus:
      a. Provide as indicated on the drawings.
   5. Vertical Bus:
      a. Provide insulation barriers over the vertical bus behind the dead front shield to provide increased safety during field service.

D. Lugs:
   1. UL listed for copper and aluminum wire:
      a. Provide lugs rated for 75-degree Celsius terminations.
      b. Provide bolted main lug terminations.

E. Molded Case Circuit Breakers:
   1. NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as:
      a. Type SWD for lighting circuits.
      b. Type HACR for air conditioning equipment circuits.
      c. Class A ground fault interrupter circuit breakers as indicated on drawings.
   2. Do not use plug-in and tandem circuit breakers.

F. Cabinet Front:
   1. All cabinet front covers shall be door-in-door with piano type hinges and quarter turn latches.
   2. Flush cabinet front with concealed trim clamps, concealed hinge, metal directory frame and flush lock, keyed alike.

3. Finish in manufacturer's standard gray enamel.

2.2 EQUIPMENT

A. Enclosure:
1. NEMA Enclosure Type, in accordance with Section 26 00 00, paragraph 1.9.C.
2. Minimum width: 20 inches.
3. Gutter space in accordance with the National Electric Code.
   a. Minimum of 4 inches of gutter space.
4. Dead-front, no live parts when the panelboard is in service.
5. Enclose entire panelboard bus assembly in a corrosion-resistant galvanized steel cabinet.
6. Four-piece front to provide ease of wiring access.
7. Lockable, hinged door over the protective devices with a flush, cylinder tumbler-type lock with catch and door pull.
   a. Minimum 2 keys per each panelboard.
   b. Key all panelboard locks alike.
8. Circuit directory frame and card on the inside of the door.
9. Interior design such that replacement of circuit breakers does not require disturbing adjacent units or removal of the main bus connectors.
10. Provide NEMA 4X enclosures with a NEMA 4X stainless steel outer enclosure, a hinged door, and a NEMA 1 interior panelboard.

2.3 ACCESSORIES

A. Provide each panelboard with a nameplate on the outside of the door with panel designation, voltage, and number of phases. Nameplate shall be attached with panhead screws. Adhesive attachment not allowed.
1. Panel Designations in ¼-inch high letters above voltage and phase in 1/8-inch high letters.

Example:

PPA-1
480/277V-3PH-4W

B. Circuit Identification Labels:
1. Provide index cards behind heavy clear plastic in cardholders, on the inside of the doors.
2. Type all information on the cards using designations in the panel schedules.
3. Laminate on both sides.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1.

B. Install filler plates for unused spaces in panelboards.

C. Provide typed circuit directory for each branch circuit panelboard, and revise directory to reflect circuiting changes to balance phase loads.

D. Install engraved plastic nameplates in accordance with Section 26 00 00 and 26 05 53.

E. Install spare conduits out of each recessed panelboard to an accessible location above ceiling.

F. Ground and bond panelboard enclosure according to Section 26 00 00 and 26 05 26, and connect equipment ground bars of panels in accordance with NFPA 70.

3.2 FIELD QUALITY CONTROL

A. Refer to Division 01, Section 01 40 10 "Quality Assurance/Quality Control."

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform circuit breaker inspections and tests listed in NETA ATS, Section 7.6.

D. Perform switch inspections and tests listed in NETA ATS, Section 7.5.

E. Perform controller inspections and tests listed in NETA ATS, Section 7.16.1.

3.3 ADJUSTING

A. Measure steady state load currents at each panelboard feeder.

B. Rearrange circuits in panelboard to balance phase loads to within 20 percent of each other.

C. Maintain proper phasing for multi-wire branch circuits.

3.4 SCHEDULES

A. Circuiting with the panelboard shall match the panel schedules as indicated on the drawings.

B. Provide type-written schedule in each panelboard.

END OF SECTION

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SECTION 26 27 25
TOGGLE SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers.

B. National Electrical Contractors Association.

C. National Electrical Manufacturers Association.

D. NFPA 70, National Electrical Code.

E. Underwriters Laboratories Inc.

1.3 SUMMARY

A. This Section includes the following:
   1. General purpose toggle switches.
   2. Special Purpose Switch (press actuated switch) for corrosive and wet areas.
   3. Rocker type switches.
   4. Single-pole, double throw, three-position switches.
   5. Dimmer switches.

B. Related Sections include the following:
   1. Division 26 Section 26 27 26 “Receptacles.”
   2. Division 26 Section 26 27 27 “Plates.”
   3. Division 26 Section 26 00 00 “Electrical General Provisions.”

1.4 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

C. Definitions of terms and other electrical considerations as set forth in the:
   1. National Electrical Code.
   2. Institute of Electrical and Electronic Engineers.
   3. National Fire Protection Association.

1.5 SYSTEM DESCRIPTION

A. Toggle switches shall be specification grade, back and/or side wired, quiet action, totally enclosed, rated 20 amperes at 120-277 VAC or as indicated on the plans, and meeting the latest applicable Federal Specifications.

B. Toggle switches used for programmable panelboards shall be as recommended by the panelboard manufacturer.

C. Provide switches with the operator style and contact arrangement as shown on the plans and as required for proper operation.

D. General purpose toggle switches shall be black everywhere except in finished rooms, where they shall be white. Special purpose switches shall have a color as shown.

1.6 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 00 and 26 00 00.

B. Product Data: For each type of product indicated.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements.
   1. Shall meet all applicable UL and CSA standards.

B. Standards.
   1. Federal Specification W-S-896E.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Eaton (Cooper) Wiring Devices.
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   3. Leviton Mfg. Company Inc. (Leviton).
   4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 MANUFACTURED UNITS

A. Comply with NEMA WD 1 and UL 20.

B. Heavy Duty Switches, 120/277 V, 20 A, back wired, catalog numbers are for black switches:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Eaton (Cooper); AH1221BK (single pole), AH1222BK (two pole), AH1223BK (three way), AH1224BK (four way).
      b. Hubbell; 1221BK (single pole), 1222BK (two pole), 1223BK (three way), 1224BK (four way).
      c. Leviton; 1221-2E (single pole), 1222-2E (two pole), 1223-2E (three way), 1224-2E (four way).
      d. Pass & Seymour; PS20AC1BK (single pole), PS20AC2BK (two pole), PS20AC3BK (three way), PS20AC4BK (four way).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
   1. Verify compliance of wiring device with dry area, wet area, corrosive area, or other area conditions which may be listed in other sections of the specifications or on the drawings.

3.2 INSTALLATION

A. Over 300 Volts
   1. Where switches used in systems of more than 300 volts between conductors, are to be ganged in outlet boxes, provide switches having no exposed live parts or use barriers between the individual switches.

B. Mount all toggle switches four (4) feet above finished floor unless otherwise noted.

C. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

D. Conductors:
   1. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

2. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
3. Existing Conductors:
    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

E. Device Installation:
1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
6. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
7. Tighten unused terminal screws on the device.
8. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

F. Dimmers:
1. Install dimmers within terms of their listing.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

END OF SECTION

SECTION 26 27 26
RECEPTACLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

A. ASME International

B. Institute of Electrical and Electronics Engineers Inc.

C. International Electrical Testing Association.

D. National Electrical Manufacturers Association.

E. NFPA 70, National Electrical Code.

F. NFPA 110, Emergency and Standby Power Systems.

G. Underwriters Laboratories Inc.

1.3 SUMMARY

A. This Section includes the following:
   1. Receptacles and receptacles with integral GFCI.
   2. Isolated-ground receptacles.
   3. Data and communications jacks.
   4. 480 V, three-phase receptacles.

B. Related Sections include the following:
   1. Division 26 Section 26 27 25 “Toggle Switches.”
   2. Division 26 Section 26 27 27 “Plates.”
   3. Division 26 Section “Electrical General Provisions.”

1.4 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. Definitions of terms and other electrical considerations as set forth in the:
   1. National Electrical Code.
   2. Institute of Electrical and Electronic Engineers.
   3. National Fire Protection Association.

1.5 SYSTEM DESCRIPTION

A. General purpose duplex receptacle shall be brown everywhere except in finished rooms, where they shall be ivory.

B. General purpose receptacles shall be rated 20 A at 125 VAC, NEMA configuration 5-20R, except as otherwise required by the plans or specifications.

C. Receptacles in the following areas shall be of the ground fault interrupter type:
   1. Outdoors.
   2. Vaults.
   3. Pipe galleries.
   4. Toilet and restrooms.
   5. Reservoirs.
   6. Below grade rooms and areas.
   7. Other areas as required by the National Electrical Code.

D. In the office areas of the plant, all receptacles shall be of the rectangular designer type.

E. On 20 A circuits with a single duplex receptacle, outside, in corrosive areas, or as indicated on the plans, provide receptacles rated 20 A at 125 VAC, NEMA configuration 5-20R.

F. Where a 125 V, 30 A receptacle is shown on the plans, use NEMA configuration 5-30R.

G. Where a 250 V, 20, 30 or 50 A receptacle is shown on the plans, use NEMA configuration 6-20R, 6-30R or 6-50R, respectively.

H. Three-phase receptacles shall be of the 3-pole, 4-wire type with a separate grounding contact.

I. 480 V receptacles shall be of the weatherproof type with spring door.

J. Furnish one matching plug for each three-phase power receptacle.

K. All receptacles powered from a UPS panelboard or identified as IG (Isolated Ground) shall:
   1. Be orange in color.
   2. The isolated ground conductor must be a dedicated conductor that runs from the IG terminal of the receptacle directly to the panelboard.

1.6 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 20 and 26 00 00.

B. Product Data: For each type of product indicated.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements.
   1. Shall meet all applicable UL and CSA standards.

B. Standards.
   1. Federal Specification W-C-596.

C. Comply with NFPA 70.

1.8 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configuration.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Eaton (Cooper) Wiring Devices.
   2. Crouse-Hinds.
   3. General Electric.
   4. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   5. Interlink.
   6. Leviton Mfg. Company Inc. (Leviton).
   7. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
   8. Russellstoll.
   9. Woodhead.

2.2 MANUFACTURED UNITS

A. Convenience Duplex Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Receptacles shall have back wire and side wire option; back wire option shall have a screw tightened pressure plate to hold the wire (catalog numbers are for black receptacles).
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Eaton (Cooper); 5352G.
      b. Hubbell; CR5352BK.
      c. Leviton; 5352E.
      d. Pass & Seymour; 5362BK.

B. Convenience Receptacles, 250 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 6-20R, and UL 498. Receptacles shall have back wire and side wire option; back wire option shall have a screw tightened pressure plate to hold the wire (catalog numbers are for black receptacles).

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; HBL5462BK.
   b. Leviton; CR20-E.
   c. Pass & Seymour; 5862BK.

C. 30A and 50A, 125V and 250V, single phase, single receptacles: Comply with NEMA WD 1, NEMA WD 6, and UL 498 (catalog numbers are for black receptacles).
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; HBL9308 (30A, 125V, configuration 5-30R), HBL9330 (30A, 250V, configuration 6-30R), HBL9367 (50A, 250V, configuration 6-50R).
   b. Leviton; 5371 (30A, 125V, configuration 5-30R), 5372 (30A, 250V, configuration 6-30R), 5374 (50A, 250V, configuration 6-50R).
   c. Pass & Seymour; 3802 (30A, 125V, configuration 5-30R), 3801 (30A, 250V, configuration 6-30R), 3804 (50A, 250V, configuration 6-50R).

D. GFCI RECEPTACLES
1. General Description: Straight blade, feed-through type: Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A.
   a. Duplex GFCI Convenience Receptacles, 125 V, 20 A, back and side wired (catalog numbers are for black receptacles) Products: Subject to compliance with requirements, provide one of the following:
      1) Eaton (Cooper); SGF20BK.
      2) Hubbell; GF20BKLA.
      3) Pass & Seymour; 2097BK.
   b. Duplex GFCI Convenience Receptacles for use in offices and other finished areas, 125 V, 20 A, back and side wired (catalog numbers are for white receptacles) Products Subject to compliance with requirements, provide one of the following:
      1) Eaton-Cooper; SGF20W.
      2) Hubbell; GF20WLA
      3) Pass & Seymour; 2097W.

E. WR RECEPTACLES
1. General Description: Required in all damp and wet locations. Provide WR equivalent to general purpose receptacles supplied.

F. 480-volt, three-phase, four-wire, 30 A receptacles:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Crouse-Hinds ARE3423.
   b. Hubbell Hubbellock® HBL21420.
   c. T&B Russellstoll™ DF3404FRAB.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount all weatherproof outlets horizontally.

B. Mount vertical receptacles with equipment ground opening down.

C. Mount horizontal receptacles with neutral opening up.

D. Three-phase receptacles shall be consistent with respect to phase connection of receptacle terminals. Errors in phasing shall be corrected at the bus, and not at the receptacle.

E. Mount all receptacles at the following heights unless otherwise noted:
   1. Office and finished areas twelve (12) inches above finished floor.
   2. Process and production areas four (4) feet above finished floor.

F. Coordination with Other Trades:
   1. Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

G. Conductors:
   1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
      c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

H. Device Installation:
   1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
   4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
   5. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
   6. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
   7. Tighten unused terminal screws on the device.
   8. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

I. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

J. Adjust locations of floor service outlets to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Receptacle Identification shall comply with Division 26 Section "Plates", and conductor Identification shall comply with Division 26 Section "Electrical Identification."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Test Instruments: Use instruments that comply with UL 1436.
   2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 2Ω are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION

SECTION 26 27 27
PLATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

A. National Electrical Manufacturers Association.

B. NFPA 70, National Electrical Code.

C. Underwriters Laboratories Inc.

1.3 SUMMARY

A. This Section includes the following:
   1. Indoor and outdoor plates for toggle switches.
   2. Indoor and outdoor plates for receptacles.
   3. Covers for floor boxes.
   4. NEMA 4 or NEMA 4X plates.

B. Related Sections include the following:
   1. Division 26 Section 26 27 25 “Toggle Switches.”
   2. Division 26 Section 26 27 26 “Receptacles.”
   3. Division 26 Section 26 00 00 “Electrical General Provisions.”

1.4 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. National Electrical Code.
   2. Institute of Electrical and Electronic Engineers.
   3. National Fire Protection Association.

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Section 26 00 00.

B. Product Data: For each type of product indicated.

C. Engraving Schedule:
   1. Description of materials and process used for premarking wall plates.
   2. Furnish complete engraving schedule for engraved nameplates.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Use square or rectangular metal plates for all applications unless otherwise indicated. Metal plates shall be steel hot-dip galvanized, cast aluminum, sherardized, or stainless steel.

B. Use stainless steel type 302 plates, 0.040" thick, in all plant and process areas.

C. Use cast iron or cast aluminum plates for cast device boxes, material to match that of the box.

D. Plates for receptacles installed outdoors or in wet or damp areas shall have gasketed stainless steel or cast aluminum flip covers. Plates shall be U.L. approved for weatherproof locations with plug inserted.
   1. For standard duplex receptacles:
      a. Crouse Hinds WLRD1.
      b. Pass & Seymour approved equal.
   2. For GFCI (ground fault) receptacles:
      a. Pass & Seymour approved equal .

E. Plates for switches installed outdoors or in wet or damp areas shall have gasketed stainless steel or cast aluminum flip covers.
   1. At outdoor locations shall be rain tight, gasketed:
      a. Crouse-Hinds DS185 cast aluminum.
      b. Pass & Seymour WP2 stainless steel.

F. Plates for special purpose switches in corrosive and wet areas requiring NEMA 4 or NEMA 4X enclosures shall be gray neoprene and weatherproof.

G. Plates for receptacles installed indoors in dry areas shall be:
   1. Stainless steel.
      a. Standard Duplex Receptacles Arraignments:
         1) Pass & Seymour Type SS8.
         2) Pass & Seymour Type SS82.
         3) Pass & Seymour Type SS83.
         4) Pass & Seymour Type SS84.
         5) Pass & Seymour Type SS85.
         6) Pass & Seymour Type SS86.

H. Decorator Receptacle Arraignments, for use with GFCI receptacle:
   1. Pass & Seymour Type SS26.

I. Plates for switches installed indoors in dry areas shall be:
   1. Stainless steel.
      a. Standard Toggle Switch Arraignments:
         1) Pass & Seymour Type SS1.
         2) Pass & Seymour Type SS2.
         3) Pass & Seymour Type SS3.
         4) Pass & Seymour Type SS4.
         5) Pass & Seymour Type SS5.
         6) Pass & Seymour Type SS6.
      b. Decorator Switch Arraignments:
         1) Pass & Seymour Type SS26.

J. Plates for receptacles and switches:
   1. Plastic and shall match color of receptacle or switch.
   2. Are only acceptable in offices and finished areas.

K. Covers for floor boxes shall be the checker plate type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ensure all plates make a firm seal with wall for recessed mounted devices.
   1. Outside edges of plates must conform with building lines.

B. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

C. Provide plates for all outlet boxes and fittings of all systems except at outlets where fixture canopies are used.

3.2 IDENTIFICATION

A. Comply with Division 26 Section 26 05 53 "Electrical Identification."
   1. Plates for switches and receptacles shall be engraved where possible.
      a. Engraved plates shall be in lieu of separate nameplates.
      b. Plates shall be engraved with the following information:
         1) Area served.
         2) Circuit fed from.
      c. Engraving shall be treated to improve visibility and, except for stainless steel plates, to prevent corrosion.
      d. Characters shall be block letter pantograph, engraved with a minimum character height of 1/8."

END OF SECTION

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SECTION 26 28 15
SAFETY SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Enclosed safety switches; fusible and nonfusible.

B. Related Sections:
   1. Division 26 Section 26 00 00 "Electrical General Provisions."
   2. Division 26 Section 26 05 53 "Electrical Identification."
   3. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. National Electrical Code.
   2. Institute of Electrical and Electronic Engineers.
   3. National Fire Protection Association.

B. System Description:
   1. Furnish and install heavy-duty type safety switches as indicated on the plans and in the specifications.
   2. Provide safety switches with the number of poles, voltage, current, and horsepower ratings as required by the load.
   3. Furnish and install a local horsepower rated safety switch for each and every motor as identified on the drawings.

1.4 SUBMITTALS

A. Furnish complete submittals in accordance with Section 26 00 00.

B. Product Data:
   1. Catalog Cut Sheets
   2. Complete data sheets indicating:
      a. Manufacturer.
      b. Type of enclosure.
      c. Voltage rating.
      d. Current rating.
      e. Horsepower rating.

f. Fused or Non-fused.
g. Cross-referenced to device table in drawings.
h. Complete dimensional and weight information.

C. Operating Manuals:
1. Furnish complete operating and maintenance instructions presenting full details for care and maintenance of equipment of every nature furnished and/or installed under this section.
a. Complete electrical ratings.
b. Complete renewal parts list.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:
1. All safety switches shall be heavy-duty type and shall comply with the following standards.
a. NEMA KS1-1990 for Type HD.
b. UL 98 30 A and below.
c. UL 489 greater than 30 A.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
1. Subject to compliance with requirements, provide product by one of the following:
a. Eaton.
a. Square D; a brand of Schneider Electric.
b. Siemens.

2.2 EQUIPMENT

A. Switch Interiors
1. With the switch door open, the switchblades shall be fully visible in the "OFF" position.
2. All current carrying parts shall be completely plated on all surfaces.
3. Arc shields shall be removable to allow access to the movable and stationary contacts.
4. Line and load connections lugs:
a. Front accessible.
b. Front removable.
c. UL listed for 60 or 75 °C copper conductors.

B. Switch Mechanism
1. Shall be of the quick make, quick break designs, so that the parting contacts cannot be prohibited or restrained from moving by the operating handle once the contacts have started to move in either the "open" or "closed" direction.
2. Operating handle must be an integral part of the enclosure frame and in no way part of the door or cover.

3. Provisions shall be made for padlocking the switch in either the "ON" or "OFF" position.
    a. "OFF" position as a standard feature with a minimum of three locks.
    b. "ON" position by drilling out a center punched marking in the handle guide for one lock.
4. Dual cover interlock to prevent opening of the switch door in the "ON" position and to prevent closing the switch mechanism with the door open.
5. Handle position shall clearly indicate whether the switch is "ON" or "OFF."

C. Ratings
1. All switches shall be UL horsepower rated for AC and/or DC with the rating not less than the load served.
2. Fused switches.
    a. Shall have a UL approved method of field conversion from standard Class H fuse spacing to Class J fuse spacing.
        1) Ratings 100 A thru 600 A at 240 V.
        2) Ratings 30 A thru 600 A at 600 V.
    b. Shall accept Class R fuses and shall have a UL listed rejection feature present to reject all fuses except Class R when Class R fuses are shown on the plans.
    c. Minimum UL listed short circuit ratings:
        1) 200,000 A RMS symmetrical when used with Class R or Class J fuses.
        2) 10,000 A RMS symmetrical when used with Class H fuses.
        3) 200,000 A RMS symmetrical when used with Class L fuses in the 800 and 1200 A size.
    d. Fuse clips shall be spring reinforced and plated.

D. Enclosures
1. At minimum, enclosures must meet the requirements for the area designation as defined and listed:
    a. In Section 26 00 00 “Electrical General Provisions.”
    b. On the contract drawings.
    c. In case of a conflict, in which case the more stringent enclosure standard shall be used.
2. NEMA 1 enclosures:
    a. General purpose enclosures with hinged doors.
    b. Sheet steel.
    c. Manufacturer’s standard gray baked enamel finish, electrostatically deposited.
3. NEMA 3R enclosures:
    a. Doors shall be securable in the open position.
    b. Provisions for bolt on hubs or Meyer hubs.
    c. Constructed of galvanized steel.
    d. Manufacturer’s standard gray baked enamel finish UV resistant, electrostatically deposited.
4. NEMA 12 enclosure:
    a. Furnish without knockouts.
    b. Hinged covers fully gasketed to assure a dust-tight enclosure.
    c. Constructed of galvanized steel.

d. Manufacturer's standard gray baked enamel finish, electrostatically deposited.

5. NEMA 4, 4X and 5 enclosures:
   a. Furnished without knockouts.
   b. Stainless steel enclosures and hardware.
   c. Fully gasketed door(s), held closed under pressure by latches.
6. NEMA 7 and 9 enclosures:
   a. Shall be used in hazardous areas as indicated on drawings.
   b. Shall be rated for the Hazardous Classification indicated.

E. Neutral and Grounding Provisions
   1. Provisions shall be made for a field installed, insulated groundable neutral kit.
      a. The neutral kit shall be furnished where indicated on the contract drawings.
   2. Equipment ground kits shall be furnished for each switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive safety switches for compliance with installation tolerances and other conditions affecting installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Provide all mounting brackets, stands, and hardware as necessary to completely support the switches at the locations indicated on the drawings.
   1. Finish and provide materials for all brackets, stands and hardware, which shall match the switch installed thereon.

B. When possible, mount switches rigidly to exposed building structure or equipment structural members.

C. When mounting NEMA 4, 4X, 5 enclosures maintain a minimum of 0.25 inch air space between the enclosure and the supporting surface.

D. Use Meyers hubs or bolt-on hubs for all conduit penetrations on NEMA 3R, 4, 4X, and 5 enclosures.

E. Connect equipment grounding conductors only to the approved equipment ground kit.

F. Furnish and install a nameplate for each safety switch.
   1. In conformance with Division 26 Section 26 05 53 "Electrical Identification".
   2. Shall identify voltage, circuit, fuse size, and equipment served on the nameplate.

G. When mounting switches on Unistrut type channel lagged to walls, channel must be run vertically behind the switch.

H. Switches must be mounted plumb and level to within ±1/32" over their longest dimension.

3.3 CLEANING

A. All switches must be vacuumed clean after installation and prior to installation of any wire.

END OF SECTION

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SECTION 26 29 13
MOTOR STARTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following motor starters rated 600 V and less:
   1. Full-voltage magnetic.
   2. Contactors.
   3. Reduced-voltage solid state.

B. For installation in motor control centers, control panels and as standalone devices.

C. Related Section:
   1. Division 26 Section "Variable Frequency Drives" for general-purpose, ac, adjustable-frequency, pulse-width-modulated drives.
   2. Division 26 Section “Electrical General Provisions”.
   3. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. SCR: Silicon-controlled rectifier.

G. Definitions of terms and other electrical considerations as set forth in the:
   1. Institute of Electrical and Electronic Engineers.
   2. National Fire Protection Association.
      a. NFPA 70; National Electrical Code.

1.4 SYSTEM DESCRIPTION

A. General Requirements

1. Starters shall be incorporated into motor control centers, individual starters, combination starters, and control panels as reflected on the drawings and noted in the specifications.
2. Ratings, components, and features shall be as shown on the single-line diagrams, control diagrams, details and schedules on the drawings.
3. All components shall be newly manufactured and of the latest construction series of the manufacturer.

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Section 26 00 00.

B. Product Data
1. Manufacturer.
2. Technical information.
3. Complete nameplate schedule.
4. Dimensions:
   a. Overall length.
   b. Overall width.
   c. Overall height.
5. Complete Bill of Material.
6. List of recommended spare parts.
7. Painting and finish procedures and materials list.
8. Manufacturer and Amperage rating for the following:
   a. Overload relays.
   b. Motor circuit protectors.
   c. Circuit breakers.
   d. Fuses.
   e. Protective relays.
9. Confirmation that the overload relay class meets the requirements of the equipment and motor suppliers for each starter.
10. Confirmation that any reduced voltage solid-state starters are matched to the respective driven loads at the installed conditions and will reliably accelerate the driven load.

C. Shop Drawings
1. Layout drawings.
2. Provide fully dimensioned and to scale layout drawings which include:
   a. All equipment furnished.
   b. Interfaces with other equipment.
   c. Allowable top and bottom conduit windows.
   d. Nameplate legends.
   e. Short-circuit current rating of integrated unit.
3. Elementary schematic diagrams.
4. One diagram for each and every starter and/or contactor.
5. Wiring diagrams showing wire numbers for all internal control wires.
6. Show lug sizes, type, and manufacturer based on the cable size as specified or indicated on the project drawings.

D. Operation and Maintenance Data
   1. Submit complete operating and maintenance instructions presenting full details for care and maintenance of equipment of every nature furnished and/or installed under this section. Manuals shall include the following:
   2. Electrical ratings
      a. Phase.
      b. Wire.
      c. Voltage.
      d. Ampacity.
   3. Complete Bill of Material.
   4. Manufacturer's operating and maintenance instructions for the starters and/or contactors and all component parts, including;
      a. Overload relays and heater elements.
      b. Protective devices (fuses, breakers, protective relays, etc.).
      c. Pilot devices.
   5. Complete renewal parts list.
   6. 11" x 17" prints of final as-built record drawings.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements
   1. Comply with NFPA 70, National Electric Code.
   2. All portions and components of the starters and/or contactors shall bear UL or other nationally recognized independent testing laboratory labels.
   3. Certifications:
      a. The manufacturer shall certify that the reduced voltage solid state starter will reliably control the acceleration and of the driven load at the installed conditions.
      b. Failure of the manufacturer to provide said certification shall be interpreted as to mean that the manufacturer has agreed that the reduced voltage solid state starter is matched to the driven load at the installed conditions and will function without fault. If the reduced voltage solid state starter fails to perform as desired the manufacturer shall replace or modify the reduced voltage solid state starter in order to achieve the desired operational conditions, as directed by the Engineer, at no additional costs to the Owner.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store motor starters indoors in clean, dry space with uniform temperature to prevent condensation. Protect motor starters from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.8 COORDINATION

A. Coordinate layout and installation of motor starters with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are referenced in Division 26 Section "Electrical General Provisions".

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full motor load, under the conditions outlined in 26 00 00.

1.10 WARRANTY

A. Provide a full two year warranty that shall cover all parts and labor needed to replace any components associated with the starters and/or contactors for a period of two years from the complete and final acceptance of the total project.
   1. Warranty requirements that require the return of parts and Owner installation of said parts will not be accepted.

1.11 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents and corresponding equipment number.
   1. Control Power Fuses: Two spare fuses of each size and type.
   2. Indicating Lights: Two of each type and color installed.
   3. Auxiliary Contacts: Furnish two spare(s) for each size and type of magnetic controller installed.
   4. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.
   5. One of each type of circuit board used in the solid state starters:
      a. Control board.
      b. Power board.
      c. Bridge rectifier.
      d. Inverter module.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
   1. Subject to compliance with requirements, provide products by one of the following:
      a. Eaton.
      b. Square D; a brand of Schneider Electric.
      c. Siemens.
      d. Rockwell Automation; Allen-Bradley.
      e. Danfoss.
      f. Multitronics.
      g. WEG

2.2 FULL-VOLTAGE STARTERS AND CONTACTORS

A. General Requirements for Full-Voltage Starters: Comply with NEMA ICS 2, general purpose, Class A.

B. Magnetic Starters: Full voltage, across the line, electrically held.
   1. Rating: The minimum size shall be a NEMA size 0. Verify motor ratings and coordinate starter and overload trip rating with actual horsepower and nameplate current ratings of motor installed.
      a. If motors provided are different in horsepower rating than those specified or indicated on the drawings, provide starters of sufficient size to accommodate the specific motors furnished.
   2. Configuration: Nonreversing or Reversing as required for the application and as shown on the drawings.
   3. Contactor Coils: Pressure-encapsulated type, and with coil transient suppressors as required for voltage or size of the coil.
      a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
   4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
   5. Magnetic contactors shall be factory adjusted and chatter free.
   6. Control Circuits: Normally the control voltage will be 120V ac, however 24V dc, may be used as required for manufacturer's special applications, and as shown on the drawings. If other control voltages are used they shall be as shown on the drawings.
      a. 120V ac shall be obtained from integral CPT, with primary and secondary fuses, CPT shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
      b. 24V dc shall be obtained from power supply, with primary and secondary fuses, control power source shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
   7. Intelligent Motor Protection Relays (IMPR)
      a. Overloads shall be fully programmable electronic relays.
      b. Overloads shall provide a 4.5:1 adjustment range matched to NEMA contactor sizes 00-6. Overload relays shall monitor all 3 phases for current. Parameter setting of the overload via network communications shall be supported.
      c. The overload shall feature a Test/Reset button.
      d. The overload shall feature General Purpose I/O – 6 Inputs, 4 Outputs.
      e. Inputs powered by 120VAC.
      f. Outputs shall be 120VAC.
      g. Automatic, network, electronic and manual reset functions shall be supported.
      h. The following protective functions shall be provided based on user configurable parameters:
         1) Overload / Underload / Jam
         2) Current Unbalance
         3) Ground fault
         4) Rapid cycling
         5) Motor Thermal Capacity

i. The overload shall provide the following user configurable parameters:
   1) Trip Class (5, 10, 15, 20, 25, 30)
   2) Command (Trip, Reset/Run, Display Lock, Network Configuration Enable)
   3) Rapid Cycle Timer
   4) Overload Restart Delay
   5) Underload Restart Delay (Dry Well Recovery Timer)
   6) Number of restarts after faults (Automatic Reset Mode)
   7) Number of restarts after Under Load fault (Automatic Reset Mode)
   8) Underload Trip Delay

j. The overload shall provide the following diagnostic and operational information:
   1) Error and Trip Indicators
   2) Ground Fault, L1, L2, L3 and 3 Phase Average Currents
   3) Current Unbalance
   4) Thermal Capacity Remaining
   5) Fault History (Last 4 faults)
   6) Product Identifier / Scale Factor
   7) Restart delay timer values
   8) Run time accumulator

k. IMPR DISPLAY UNIT
   1) Overload information and faults shall be viewed from the front of each starter unit.
   2) The display unit shall provide the capability of changing overload settings.
   3) Each Starter unit shall have a door mounted display. The display unit shall be capable of replacing all pilot lights and pushbuttons and shall include a 4X20 liquid crystal, extended temperature range, backlit display. The display shall be provided with password protect functionality to prevent tampering of set points.
   4) Ten membrane pushbuttons shall be an integral part of the display unit. The pushbuttons shall provide the following functionality:
      a) Motor Start
      b) Motor Stop
      c) Overload Reset
      d) Local/Remote Operation
      e) Menu navigation (scroll/select/enter)
   5) The liquid crystal display shall display the following motor data information:
      a) Average current, individual line currents, and current unbalance
      b) Current to ground
      c) Stores last five faults with time and date stamp, including voltages /currents at time of trip
      d) Frequency
      e) Average voltage, line-line voltages, and voltage unbalance
      f) Instantaneous power
      g) Power factor

6) The liquid crystal display shall display the following motor management information:
   a) Total motor run-time (re-settable)
   b) Time and date of last five faults, along with voltage and current at time of trip
7) Number of motor starts/hour
   a) I/O status
   b) Start duration
   c) Starting current
   d) Date/Time
   e) kWh consumed (re-settable)
8) The unit display shall have two communication ports: one for communications to the solid state overload and one shall be capable of communicating to overload programming and monitoring software.

8. Starter shall support **ETHERNET/IP** communication protocol without the use of gateways.

C. Combination Magnetic Starter: Factory-assembled combination of magnetic starter, overcurrent protective device, and disconnecting means. The type of overcurrent protective device used shall be as shown on drawings.
1. The overcurrent protective device shall be rated for the short circuit as shown on the drawings. The overcurrent protective device and the starter shall be rated together to provide Type 2 coordination for starter protection from very high short circuit currents.
2. MCP Disconnecting Means:
   a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
   b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle are required as shown on drawings.
3. MCCB Disconnecting Means: If a molded-case circuit breaker is shown on the drawings it shall be provided in accordance with the following:
   a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
   b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle are required as shown on drawings.

D. NEMA Contactors

1. Furnished in combination with thermal magnetic circuit breakers.
2. Electrically held, minimum NEMA size 1.
3. Open type, coil voltage, and number of poles as specified or indicated on the drawings.
4. Same as magnetic starters but without overload relays.
5. Installation same as that for starters unless otherwise noted.

2.3 REDUCED-VOLTAGE SOLID-STATE STARTERS

A. General Requirements for Reduced-Voltage Solid-State Starters: Comply with UL 508.

B. Reduced-Voltage Solid-State Starters: An integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relay; suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
1. Configuration: Heavy duty, nonreversible or reversible as required for the application and as shown on the drawings.
2. Starting Mode: Manufacturer shall provide information and training for the different types of field selectable starting modes that are available.
3. Stopping Mode: Coast to stop.
4. Shorting (Bypass) Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Solid-state controller protective features shall remain active when the shorting contactor is in the bypass mode.
   a. If the Solid-State controller protective features are not active in the bypass mode then a Solid-State overload relay shall be provided. It shall be the same as specified for a Full-Voltage Starter.
5. Shorting Contactor Coils: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating.
6. Logic Board: Shall be provided with environmental protective coating.
7. Control Circuits: Normally the control voltage will be 120V ac, however 24V dc, may be used as required for manufacturer’s special applications, and as shown on the drawings. If other control voltages are used they shall be as shown on the drawings.
   a. 120V ac shall be obtained from integral CPT, with primary and secondary fuses, CPT shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
   b. 24V dc shall be obtained from power supply, with primary and secondary fuses, control power source shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
8. Adjustable acceleration-rate control using voltage or current ramp, and adjustable starting torque control with up to 350 percent current limitation for 15 seconds.
9. SCR bridge shall consist of at least two SCRs per phase, providing stable and smooth acceleration without external feedback from the motor or driven equipment.
10. Keypad, front accessible; for programming the controller parameters, functions, and features; shall be manufacturer's standard and include not less than the following functions:
    a. Adjusting motor full-load amperes, as a percentage of the controller's rating.
    b. Adjusting current limitation on starting, as a percentage of the motor full-load current rating.
    c. Adjusting linear acceleration and deceleration ramps, in seconds.

d. Initial torque, as a percentage of the nominal motor torque.
e. Adjusting torque limit, as a percentage of the nominal motor torque.
f. Adjusting maximum start time, in seconds.
g. Adjusting voltage boost, as a percentage of the nominal supply voltage.
h. Selecting stopping mode, and adjusting parameters.
i. Selecting motor thermal overload protection class between 5 and 30.
j. Activating and de-activating protection modes.
k. Selecting or activating communication modes.

11. Digital display, front accessible; for showing motor, controller, and fault status; shall be manufacturer's standard and include not less than the following:
    a. Controller Condition: Ready, starting, running, stopping.
    b. Motor Condition: Amperes, voltage, power factor, power, and thermal state.
    c. Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor underload, overcurrent, shorted SCRs, line or phase loss, phase reversal, and line frequency over or under normal.
12. Controller Diagnostics and Protection:
    a. Microprocessor-based thermal protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
    b. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and underload conditions; and line frequency over or under normal.
    c. Input isolation contactor that opens when the controller diagnostics detect a faulted solid-state component or when the motor is stopped.
13. Remote Output Features:
    a. All outputs prewired to terminal blocks.
    b. Form C status contacts that change state when controller is running.
    c. Form C alarm contacts that change state when a fault condition occurs.
14. Other Features:
    a. Surge suppressors in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
15. Starter shall support **ETHERNET/IP** communication protocol with the use of gateways.
    a. Shall provide the following information and/or control on a communications network.
        1) Average current.
        2) Percent phase imbalance.
        3) Percent thermal capacity used.
        4) Trip cause.
        5) Full load current setting.
        6) Start.
        7) Stop.

2.4 ENCLOSURES

A. Motor starters:
    1. NEMA ICS 6, to comply with environmental conditions at installed location.

2. Enclosures for combination starters shall be the type as specified on the drawings or in section 26 00 00 “Electrical General Provisions”.

2.5 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices:
   1. NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

B. Auxiliary Contacts
   1. Contact ratings as per NEMA A600 rating.
   2. Auxiliary contacts rated 10 Amps at 600 volts.
   3. Provide all contacts shown on the drawings, and any additional contacts required for proper operation.
   4. Provide at least 1 normally open and 1 normally closed spare auxiliary contact with each starter.

C. Relays
   1. General Requirements:
      a. Provide transient surge protection across the coil of each relay.
   2. General Purpose Relays:
      a. General purpose relays shall be plug-in type.
      b. Contacts rated 10 Amps at 120 VAC minimum.
      c. With LED indication for energization.
      d. Quantity and type of contacts shall be as shown on the Drawings or as needed for system compatibility.
      e. Each relay shall be enclosed in a clear plastic heat and shock resistant dust cover.
      f. Sockets for relays shall have screw-type terminals.
      g. Relays shall be:
         1) Potter and Brumfield Type KRP or KUP.
         2) IDEC.
         3) Square D Type K.
         4) Allen Bradley.
         5) Or, Engineer Approved Equal.
   3. Slave Interposing Relays:
      a. Additional slave relays shall be provided when the number or type of contacts shown exceed the contact capacity of the specified relays and timers.
      b. Additional relays shall be provided when higher contact rating is required to interface with starter circuits or other equipment.
      c. Shall be provided to compensate for voltage drop due to long wire runs.
      d. The slave and interposing relays shall be of type general-purpose relay.
   4. Control Relays
      a. Including all electrically held, pneumatic time delay, mechanically latching, and solid-state time delay relays.
      b. Convertible contact cartridges to convert any contact from a normally open to a normally closed configuration.
      c. Contact material shall be fine grade silver.

d. Contact cartridges to be enclosed having a clear cover to allow for inspection of the contacts.
e. Contact rating NEMA A600.
f. Control Voltage 120 VAC.
g. Provide transient surge protectors across the coil of each control relay.
h. As manufactured by:
1) Allen Bradley 700P.
2) Square D850 Type X.
3) Cutler Hammer AR.
4) IDEC.
5) SquareD.
6) Or, Engineer Approved Equal.

5. Time Delay Relays
a. Time delay relays shall be pneumatic on-delay or off-delay type.
b. Contacts shall be rated 10 Amps at 120 VAC.
c. Units shall include adjustable dial with graduated scale covering the time range in each case.
d. Provide transient surge protection across the coil of each relay.
e. As manufactured by:
1) Agastat Series 7000.
2) Allen-Bradley.
3) IDEC.
4) SquareD.
5) Or, Engineer Approved Equal.

D. Manual Operator Interface Devices.
1. Control Components - Oil Tight
a. All operators, pushbutton, selector switches, and pilot lights are to be of the same manufacturer.
b. NEMA Type 13 oil-tight.
c. With synthetic rubber gasket.
d. Heavy duty.
e. Industrial grade full size 1-3/16" (30 mm) diameter.
f. Pushbutton units:
1) Contacts rated
a) NEMA A600
b) 600 VAC maximum
c) Make = 7,200 VA
d) Break = 720 VA
2) Color Code
a) Red: Stop
b) Green: Start
c) Orange: Open
d) Blue: Closed
3) As manufactured by
a) Allen Bradley 800T Series.
b) SquareD Harmony 9001SK Series.
c) IDEC TWTD Series.
d) Cutler Hammer 10250T Series.

e) Or, Engineer Approved Equal.

4) Furnish one spare normally open and normally closed contact with each switch.

g. Selector switches

1) Contacts rated

a) NEMA A600

b) 600 VAC maximum

c) Make = 7,200 VA

d) Break = 720 VA

2) As manufactured by

a) Allen Bradley 800T Series.

b) SquareD Harmony 9001SK Series.

c) IDEC CS Series.

d) Cutler Hammer 10250T Series.

e) Or, Engineer Approved Equal.

3) Furnish one spare normally open contact and normally closed contact with each switch.

h. Pilot lights

1) Transformer type pilot lights

2) 120 VAC

3) Push-to-Test

4) Provide indicating light colors as follows:

a) White: Power On

b) Green: On / Running

c) Red: Off

d) Amber: Abnormal / Alarm Condition / Failure

e) Blue: Closed

5) As manufactured by

a) Allen Bradley 800T Series.

b) SquareD Harmony 9001SK Series.

c) IDEC TWTD Series.

d) Cutler Hammer 10250T Series.

e) Or, Engineer Approved Equal.

2. Control Components Corrosive Areas

a. All operators, pushbuttons, selector switches, pilot lights are to be of the same manufacturer.

b. NEMA 4X corrosion resistant.

c. Exterior parts to be made of high impact strength fiberglass reinforced polyester.

d. Incorporating an internal neoprene boot which completely encloses all internal parts.

e. Industrial grade full size 1-3/16" (30mm) diameter.

f. Pushbutton:

1) Having an integral wiping gasket around the pushbutton that cleans the wall of the pushbutton guard of any foreign material accumulation as the button is operated.

2) Contacts rated:

a) NEMA A600.

b) 600 VAC maximum.

c) Make = 7,200 VA.
d) Break = 720 VA.

3) Color code:
a) Red: Stop / Off
b) Green: Start / On
c) Orange: Alarm / Failure
d) Blue: Open

4) As manufactured by:
a) Cutler Hammer 10250T Series.
b) SquareD Harmony 9001SK Series.
c) Allen Bradley 800H Series.
d) Or, Engineer Approved Equal.

g. Selector switches:

1) Contacts rated:
a) NEMA A600.
b) 600 VAC minimum.
c) Make = 7,200 VA.
d) Break = 720 VA.

2) As manufactured by:
a) Cutler Hammer 10250T Series.
b) SquareD Harmony 9001SK Series.
c) Allen Bradley 800H Series.
d) Or, Engineer Approved Equal.

h. Pilot lights:

1) Transformer type pilot lights.
2) 120 VAC.
3) Corrosion resistant.
4) Push-to-Test.
5) With LED type lamps
6) Provide indicating light colors as follows:
a) White: Power On / Normal Condition
b) Green: On / Running
c) Red: Off / Stopped
d) Amber: Abnormal / Alarm Condition / Failure
e) Blue: Closed

7) As manufactured by:
a) Cutler Hammer 10250T Series.
b) SquareD Harmony 9001SK Series.
c) Allen Bradley 800H Series.
d) Or, Engineer Approved Equal.

E. Terminal Blocks

1. Field terminal or inter-cabinet wiring blocks.
a. DIN-Rail Mounted.
b. Terminal to be screw type.
c. Recessed terminal hardware to minimize the possibility of contact with current carrying parts.
d. Molded of high dielectric material.
e. Minimum rating 600 VAC.

f. All external connections to and from all control panels must be via terminal blocks including control circuits and solenoid circuits.
g. All individual terminals and terminal blocks shall be marked in a permanent manner with printed identification.
h. Grounding Terminals blocks shall be Green/Yellow
i. As manufactured by:
1) Allen Bradley
2) Phoenix Contact.
3) Wago.
4) ABB/Entrelec.
5) Or, Engineer Approved Equal.

F. Conductors Within Control Panel
1. Wire markers:
a. All conductors within the control panel are to be permanently marked with wire numbers at each end.
b. Wire numbers are to correspond to the wire numbers on the manufacturers' control drawings and as detailed in Section 26 05 53.
c. Wire numbers are to correspond to the terminal block number to which they are attached in the control panel.
d. Markers shall comply with the requirements of Section 26 05 53.

G. Nameplates
1. In conformance and full compliance with Section 26 05 53.
a. All control components within the control panel shall have engraved laminated plastic nameplates secured with stainless steel screws or epoxy cemented in place. Nameplates cannot be attached to the covers of the panel channel.
2. All components on the front cover shall be identified by nameplates.
a. Use standard manufacturer engraved nameplates for all pushbuttons, and selector switches only if color matches that specified for engraved nameplates.
1) If not then furnish nameplates to match colors as specified in Section 26 05 53.
b. Use engraved plastic laminated nameplates for all other devices, keyboards, and annunciator LED's.
c. All control panels shall have an engraved, plastic, laminated nameplate identifying the control panel, voltage, and feeder breaker and panel.
d. On NEMA 4X enclosures use an epoxy based adhesive to affix nameplates to panel.
3. Shall be provided for instruments, function titles for each group of instruments, and other components mounted on the front of panel.
4. A nameplate shall be provided for each signal transducer, signal converter, signal isolator, each electronic trip, and the like, mounted inside the panel. These shall be descriptive, to define the function and system of such element.
5. Lettering, styles, abbreviations and sizes shall be in conformance with ISA-RP-60.6 (1984) with an intended viewing distance of 3 to 6-feet as shown or as selected by the Engineer.

H. Control Circuit Breakers.
   1. Each 120 VAC control circuit, instrument, or loop shall be powered from an individual control circuit breaker or fused terminal block.
   2. DIN-Rail mounted using the same DIN-Rail as used for the terminal blocks.
   3. Manual ON-OFF Switch
   4. Rated 240 VAC.
   5. Rated 2000 AIC.
   6. Current Ratings as required.
   7. Provide complete nameplate identifying each circuit.
      a. In conformance with Section 26 05 53.
   8. As manufactured by:
      a. ABB S200 Series.
      b. Siemens 5S Series.
      c. Allen-Bradley 1489/1492 Series.
      d. Schneider Electric Multi 9 Series.
      e. SquareD QYU Series.
      f. Or, Engineer Approved Equal.

I. Fuses
   1. Isolate Group of PLC/PAC with fuses as detailed in the Contract Drawings.
   2. Isolate Group of PLC/PAC Digital Inputs with fuses as detailed in the Contract Drawings.
   3. Isolate all PLC/PAC Analog inputs with fuses as detailed in the Contract Drawings.
   4. Coordinate fuse size below internal output protection of the PLC/PAC output cards.
   5. Fuses to be terminal block mounted.
      a. With Lighted Fuse Puller.
   6. Furnish Nameplate identifying each fuse.
      a. Section 26 05 53.
   7. Spare Fuses in conformance with paragraph 1.11 of this Section.
   8. As manufactured by:
      a. Allen-Bradley.
      b. ABB/Entrelec.
      c. Phoenix Contact.
      d. Wago.
      e. Or, Engineer Approved Equal.

J. Field/Remote Connections
   1. All field/remote connections shall be made via terminal blocks.
   2. Furnish an individual terminal block space for each wire.
      a. Two wires on one terminal block shall be not be allowed.
   3. Furnish an empty wire channel on the panel adjacent to the field/remote terminal block strip to be used to route the field/remote wires prior to connection to the terminal blocks.

K. Pump Monitor Relay: Where indicated on Contract Drawings, provide a Pump Monitor Relay for motor temperature and/or moisture protection for integration with motor control circuit. Relay to be factory wired in applicable Motor Control Center bucket or Manufacturer Control Panel as applicable. Relay to be PumpSafe Model A or Equal.

L. Motor Protection Relay: Drive enclosure to have a motor protection relay for RTD inputs as shown on Drawings. Relay to be:
   1. GE Multilin 369
   2. Or Engineer Approved Equal

M. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings. Space heaters shall be installed when specified on the drawings.

N. Power factor correction capacitors shall be sized and provided by the starter manufacturer when they are shown on the drawings.

2.6 SOURCE QUALITY CONTROL

A. RVSS Starters
   1. The manufacturer of the respective RVSS starter shall supply certified test results to confirm that the controller has been tested to substantiate designs according to applicable ANSI and NEMA standards. The tests shall verify not only the performance of the unit and integrated assembly, but also the suitability of the enclosure venting, rigidity, and bus bracing. In addition, the unit shall be factory tested in accordance with ANSI standards.
   2. The RVSS starter manufacturer shall test for noise immunity on both input and output power connections and provide test results to the Engineer. Noise testing shall be performed in accordance with NEMA ICA 2-230.40.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive motor starters, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine motor starters before installation. Reject motor starters with electronic circuitry that is moisture damaged or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Combination Starters shall be installed in accordance with manufacturer recommendations and as specified in this section.

B. Combination Wall-Mounted Starters: Install motor starters on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For starters not at walls, provide freestanding racks as shown on the drawings.

C. Combination Floor-Mounted Starters: Install motor starters on 3-1/2 inch raised concrete housekeeping pad, unless otherwise indicated, as shown on the Contract Drawings. Comply

with requirements for concrete referenced in Division 26 Section “Electrical General Provisions”.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify motor starters, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between motor starters remote devices and control system. Comply with requirements in Division 26 Section "600 Volt or Less Wires and Cables."

B. Bundle, train, and support wiring in enclosures outside of wireway. Wireway shall be utilized whenever possible.

C. Connect selector switches and other automatic-control selection devices where applicable as shown on drawings.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Visual and Mechanical Inspection:
    a. Compare equipment nameplate data with Drawings and Specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Verify the unit is clean.
    e. Verify contactors:
        1) Verify mechanical operation.
        2) Inspect contact gap, wipe, alignment, and pressure are in accordance with manufacturer’s published data.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Inspect starters, wiring, components, connections, and equipment installation.
   2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
   3. Test continuity of each circuit.
   4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify the Engineer and Construction Manager before starting the motor(s).
   5. Test each motor for proper phase rotation.
   6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   8. Manufacturer's Field Service: Engage a factory-authorized service representative for startup and inspection of Reduced-Voltage Solid-State Starters.
   9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Motor starters will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports including a certified report that identifies motor starters and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state starters.

3.7 TRAINING

A. Provide the services of the manufacturer's technical representative to provide training in start-up, adjustment, and troubleshooting of the following equipment:
   1. Reduced Voltage Solid-State Starters: minimum of 8 hours at the Owner's facility.

END OF SECTION

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SECTION 26 29 23
VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers.
   1. IEEE C62.41: Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
   2. IEEE 519: Recommended Practices and Requirements for Harmonic Control in Electric Power Systems. 1992. (ANSI)

B. InterNational Electrical Testing Association
   1. NETA ATS-2017: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

C. National Electrical Manufacturers Association
   1. NEMA 250-97: Enclosures for Electrical Equipment (1000 Volts Maximum)
   2. NEMA AB 1-99: Molded Case Circuit Breakers and Molded Case Switches
   3. NEMA ICS 2-93: Industrial Control and Systems: Controllers, Contactors and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC
   4. NEMA KS 1-96: Enclosures and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
   5. NEMA MG 1-98: Motors and Generators (Including Revisions 1 and 2)

D. National Fire Protection Association
   1. NFPA 70: National Electrical Code

E. Underwriters Laboratories Inc
   1. UL-50 Standards for Enclosures for Electrical Equipment.

1.3 SUMMARY

A. This Section includes solid-state, PWM, VFDs for speed control of three-phase, squirrel-cage induction motors.

B. The VFD shall be housed in a custom engineered enclosure that includes all appurtenances required to meet the requirements of the Drawings and Specifications. This will include but not limited to:
   1. VFD
   2. Motor protection relay
   3. Control devices (logic, indication, etc.)
   4. Communication devices

C. Related Sections include the following:
   1. Division 26 Section “Electrical General Provisions”.

1.4 DEFINITIONS

A. IGBT: Insulated gate bipolar transistor.

B. LAN: Local area network.

C. PID: Control action, proportional plus integral plus derivative.

D. PWM: Pulse-width modulated.

E. VFD: Variable frequency drive.

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Section 26 00 00.

B. Submittal shall be custom prepared by the VFD manufacturer and shall be specific for the equipment furnished.

C. Product Data:
   1. Manufacturer of the VFD.
   2. Manufacturer of all components of the VFD.
   3. Dimensions:
      a. Height.
      b. Width.
      c. Depth
   4. Weight.
   5. Nameplate Schedule.
   6. Bill of material.
   7. Ratings:
      a. Voltage.
      b. Phase.
      c. Current.
      d. Interrupting rating.
      e. Momentary current rating.
      f. Confirmation that the drive is sized for the full motor horsepower at the installed altitude.
   8. List of recommended spare parts.

D. Shop Drawings:
   1. Complete plan and elevation drawings showing:
      a. All dimensions.
      b. Panel, sub-panel and component layout indexed to the Bill of Material.
      c. Conduit connections.
      d. Required clearance around equipment for working clearances and required area above and around VFDs where pipe and ducts are prohibited.

2. Complete schematic, wiring and interconnection diagrams showing connections to both internal and external devices:
    a. Wiring diagrams shall include terminal number and wire numbers.
3. Complete single-line and three-line diagrams including, but not limited to, circuit breakers, motor circuit protectors, contractors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system:
    a. Device electrical ratings shall be clearly indicated on the Drawings.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For VFDs, all installed devices, and components to include in emergency, operation, and maintenance manuals. Include the following:
1. Routine maintenance requirements for VFDs and all installed components.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. A qualified manufacturer specializing in manufacturing products specified in this section with minimum five years of experience.
2. Provide information for and location of a service center capable of providing training, parts, and emergency maintenance and repairs.
    a. Type of technical support available (e.g., system engineering and technician).
    b. Location of field service personnel.
    c. Field service daily rates in dollars per hour and dollars per day.
    d. Guaranteed response times to service requests.

B. Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer.

C. All VFD's shall be 100% factory tested to ensure proper performance upon delivery.

D. VFD's installed in panels shall be 100% factory tested as a system by the VFD supplier.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with NFPA 70.

1.7 STANDARDS

A. The VFD shall be UL listed and not require external fuses except where input power is supplied from multiple transformer secondaries.

B. All VFD and VFD systems shall be designed in accordance with applicable portions of NEMA standards, and panel build-ups shall be manufactured to comply with UL508A or other nationally recognized independent testing laboratory label.

C. The VFD shall be compatible with the installation requirements of interpretive codes such as National Electric Code (NEC) and Occupational Safety & Health Act (OSHA).

D. The VFD shall be capable of operating in compliance with IEEE 519-2014.

E. The VFD shall meet IEC 61200-2 for vibration levels.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full motor load, under the conditions outlined in 26 00 00.

1.10 WARRANTY

A. All equipment furnished under this section shall be warranted by the contractor and the equipment manufacturers for a period of two (2) years from date of purchase.

B. Without additional charge the Manufacturer shall replace any work or material they have provided which develops defects within two years from date of substantial completion of the project.

C. All materials and equipment shall be warranted against defective materials, design and workmanship.

D. During the warranty period, the Manufacturer or his authorized dealer is required to make the necessary repairs or replacements on site.

E. Warranties which mention that the part must be returned to the factory are not acceptable.

F. During the warranty period, the OWNER will not accept charges for:
   1. Travel time.
   2. Mileage.
   3. On-site repair labor.

G. Warranty shall list any and all items excluded.

H. If necessary, as determined by the OWNER, any repairs must be made on a premium time basis.

1.11 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. One set of all power and control fuses for each type and rated size of VFD.
   2. One complete main control keypad for each type and rated size of VFD.

3. One spare fan for each type and rated size of VFD unit.
4. Two sets of ventilation filters for each VFD unit (if applicable in VFD cabinet louvers).
5. Any special dedicated tools for emergency service and troubleshooting.
6. One set of power electronics for each type and rated size of VFD.
7. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
2. Square D; a brand of Schneider Electric.
3. Rockwell Automation; Allen-Bradley.
4. US Drives.

2.2 VARIABLE FREQUENCY DRIVES

A. Description: NEMA ICS 2, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.
1. Regulator technology shall be software configurable to either V/Hz (single or multi motor) mode or Sensorless Dynamic Torque Vector mode (single motor). Full, closed loop flux vector control shall be available for heavy duty applications. In V/Hz mode at base speed (60 hertz) and below, the Drive shall operate in constant volts per hertz mode. Above base speed (60 hertz), the Drive may selectively operate in either a constant volt per hertz mode or a constant voltage extended frequency mode.

B. Output Rating: 3-phase; for a variable torque load.

C. Contractor to coordinate ability of VFD to supply load at project elevation.

D. Unit Operating Requirements:
1. Input ac voltage tolerance of 480 V, plus or minus 10 percent.
2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
3. Minimum Efficiency: 96 percent at 60 Hz, full load.
4. Minimum Displacement Primary-Side Power Factor: 96 percent.
5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
6. Starting Torque: 100 percent of rated torque or as indicated.
7. Speed Regulation: Plus or minus 1 percent.

E. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 2 to a minimum of 22 seconds.
4. Deceleration: 2 to a minimum of 22 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

F. Self-Protection and Reliability Features:
   1. Input transient protection by means of surge suppressors.
   2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
   3. The Drive shall have a selectable electronic inverse time thermal overload function as required by NEC and UL Standard 991 for an AC Induction Motor (Refer to applicable codes for specific installation requirements). The overload shall be programmable from 20 - 135% of Drive rated current. Drive overload type shall be software configurable to protect general-purpose ac motors by reducing overload level at reduced motor shaft speeds. External motor overload relays for single motor applications shall not be required. Drive overload software shall be configurable to protect "inverter duty" AC motors without the use of external motor overload relays.
   4. Notch filter to prevent operation of the drive-motor-load combination at a natural frequency of the combination.
   5. Instantaneous line-to-line and line-to-ground overcurrent trips.
   6. Loss-of-phase protection.
   7. Reverse-phase protection.
   8. Short-circuit protection.
   9. Motor overtemperature fault.

G. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

H. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

I. Harmonic Filtering: The electrical power distribution system including VFDs shall be capable of operating in compliance with IEEE 519-2014 at each switchboard. Active harmonic filtering is a requirement at each switchboard to mitigate harmonics of the VFDs supplied by the switchboard. See Specification Section 26 24 13. The filter shall be meet the following:
   1. Supplied by the switchboard or VFD manufacturer.
   2. The size of filter shall be determined by the drive manufacturer or the manufacturer's representative.
   3. Provided in NEMA 1 enclosure with incoming power disconnect.
   4. Square D AccuSine PCS+.
   5. Mesta DPM.
   6. OR EQUAL.

J. VFD Output Filtering: It is the responsibility of the Contractor and the drive Manufacturer to coordinate the drive with the motor and the installed cable length to ensure that the drive can charge the cable capacitance and that no damage can occur to the motor as a result of standing waves, high carrier frequency, high levels of dv/dt, etc. Any changes that may need to be made in order to protect the equipment shall be made by the Contractor and the Manufacturer at no additional costs to the OWNER.

K. Drive Features: The features of the drive shall include the following:

1. The Drive shall have a keypad that shall be extendible, by optional cable, to a remote location up to 30 feet from the drive. This keypad shall be capable of mounting on the enclosure door. The keypad shall include the following buttons, allowing 3 modes of operation: Forward/Reverse/Stop/Start/Jog keys, Drive reset key, Reference increment/decrement keys. The keypad shall have a back-lit liquid crystal display (LCD) which can be configured to display frequency, current, function code set points, or Drive status and fault codes. It shall display text, providing display of:
    a. Programming Mode: Function Code Numbers, Set points, and Status.
    b. Diagnostic Mode: Fault Indication in plain English.
    c. I/O Check Parameters: Analog and digital input/output signal status. These parameters shall include:
        1) Output frequency (Hz).
        2) Motor speed (rpm; adjustable for 2 to 8 pole motors).
        3) Motor status (running, stop, fault).
        4) Motor current (amperes).
        5) Motor torque (percent).
        6) Motor power consumption (kW).
        7) Fault or alarming status (code).
        8) PID feedback signal (percent).
        9) DC-link voltage (VDC).
        10) DC bus current (amperes).
        11) Set-point frequency (Hz).
        12) Motor output voltage (V).
    d. Status Lights: LED indicators on the keypad shall indicate the following conditions:
        1) Power on.
        2) Run.
        3) Stop.
        4) Fault.
2. The Drive shall display operating data and fault information in plain English.
3. Upon a fault condition, the LCD shall be capable of displaying the last three (3) faults. These faults will be stored in memory and selectively be displayed on the LCD.
4. Unless the application requires it, the Drive shall operate as an open-loop control system requiring no feedback devices.
5. The Drive shall maintain set frequency regardless of load fluctuations.
6. The Drive will have an adjustable starting torque and Voltage Boost.
7. All Drive Operating Function Codes shall be stored in non-volatile memory (EEPROM). Potentiometer adjustments are not required nor allowed. The Drive will have a default set of Function Code settings.
8. The Drive shall have adjustable switching frequency settings ranging from 1000 to 3000 Hz.
9. The Drive shall be able to operate with its output disconnected for troubleshooting and startup.
10. The Drive shall have a selectable function to prevent reverse operation of the drive

L. Control Signal Interface:
1. The drive shall accept up to 6 programmable digital inputs (from external dry contacts). The following are some of the required functions:
    a. Run/Stop forward command.

b. Run/Stop reverse command.
c. Speed control from external analog input.
d. Speed control from keypad.
e. E-Stop command.
f. Run at fixed frequencies.

2. A minimum of 2 analog inputs (0 to 10 V or 4-20 mA).
3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the owners control system:
   a. 0 to 10-V dc.
   b. 4-20 mA.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
   e. RS485.
   f. Keypad display for local hand operation.
4. Output Signal Interface:
   a. A minimum of 2 analog output signals (4-20 mA), which can be programmed to any of the following:
      1) Output frequency (Hz).
      2) Output current (load).
      3) Output voltage.
      4) DC-link voltage (VDC).
      5) Motor torque (percent).
      6) Motor speed (rpm).
      7) Set-point frequency (Hz).
      8) Other programmable functions.
5. Remote Indication Interface: A minimum of 10 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the signals shown in the bucket wiring diagrams.

M. Communications: Provide an **ETHERNET/IP** interface allowing VFD to be used with an external system within a multi-drop LAN configuration without the use of gateways.

N. Integral Disconnecting Means: KS 1, non-fusible switch with lockable handle.

2.3 ENCLOSURES

A. Enclosures to be NEMA rated per Drawings.

2.4 ACCESSORIES

A. Devices shall be factory installed in drive enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Control Relays: Auxiliary and adjustable time-delay relays.

D. Motor Protection Relay: Drive enclosure to have a motor protection relay for RTD inputs as shown on Drawings. Relay to be:
1. GE Multilin 369
2. Or Engineer Approved Equal

E. Standard Displays:
   1. Output frequency (Hz).
   2. Set-point frequency (Hz).
   3. Motor current (amperes).
   4. DC-link voltage (VDC).
   5. Motor torque (percent).
   6. Motor speed (rpm).
   7. Motor output voltage (V).

F. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

C. Verify that building environment can be maintained within the service conditions required by the manufacturer.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Anchor each VFD assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

B. Install VFDs on concrete bases.

C. Install in accordance with NEMA ICS 3.1.

D. Tighten accessible connections and mechanical fasteners after placing controller.

E. Motor Data: Neatly type label inside controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.

3.3 IDENTIFICATION

A. Identify VFDs, components, and control wiring according to Division 26.

B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices according to Division 26.

B. Bundle, train, and support wiring in enclosures.

3.5 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26.

3.6 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each enclosed drive element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
   1. Inspect drives, wiring, components, connections, and equipment installation.
   2. Assist in field testing of equipment including pre-testing and adjusting of solid-state drives.
   3. Report results in writing.

C. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.7 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency drives.

END OF SECTION

SECTION 26 32 00
PACKAGED ENGINE GENERATOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers.

B. National Electrical Contractors Association.

C. American Society for Testing and Materials (ASTM):
1. A53 – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
2. A106 – Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
3. A181 – Specification for Carbon Steel Forgings for General Purpose Piping.
4. A240 – Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
5. A536 – Specification for Ductile Iron Castings.
6. D2310 Standard Classification for Machine-Made Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

D. International Fire Code Institute (IFCI):
1. Uniform Fire Code (UFC).

E. National Electrical Manufacturers Association (NEMA):
1. NEMA 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum)
2. NEMA MG-1 – Motor and Generators.

F. National Fire Protection Association (NFPA):
1. NFPA 30 – Flammable and Combustible Liquids Code.
2. NFPA 37 – Installation and Use of Stationary Combustion Engines and Gas Turbines.
3. NFPA 70 – National Electrical Code.
4. NFPA 99 – General Overall Requirements.
5. NFPA 110 – Emergency and Standby Power Systems.

G. Underwriters Laboratories (UL):
1. UL 142 – Standards for Steel Aboveground Tanks for Flammable and Combustible Liquids.
2. UL 508 – Industrial Control Equipment.
3. UL 2200 – Standards for Stationary Engine Generator Assemblies.

1.3 SUMMARY

A. This Section includes packaged engine-generator sets for standby power supply with the following features:
   1. A single Diesel engine.
   2. Unit-mounted system.
   3. Coolant Jacket heater (block heater).
   4. Unit-mounted control and monitoring.
   5. Batteries and battery charger.
   6. Battery blanket heater.
   7. Fuel system and fuel storage tank(s).
   8. Exhaust system.
   9. Supporting and mounting skid.
      a. Performance requirements for sensitive loads.
      b. Outdoor weatherproof, sound attenuating enclosure.
      c. Enclosure integrated panelboard for generator circuits.

B. Related Sections include the following:
   1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets. Transfer switch shall be furnished by generator manufacturer.
   2. Division 26 Section “Electrical General Provisions”.

1.4 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Section 26 00 00.

B. Product Data: For each type of packaged engine generator indicated. Include rated capacities at project elevation, operating characteristics, and furnished specialties and accessories. In addition, include the following:
   1. Thermal damage curve for generator.
   2. Time-current characteristic curves for generator protective device.
   3. Type and grade of fuel recommended.
   4. Fuel and lubricating oil consumption at:
      a. 50 percent load.
      b. 75 percent load.
      c. 100 percent load.
   5. Type and grade lubricating oil recommended.
   6. Amount of lubricating oil required per oil change.
   7. Recommended lubricating oil change periods.
      a. By hours run.
      b. By time.
   8. Combustion air required.

9. Cooling air required.
10. Gauges normally furnished with engine and the normal operating range of each.
    a. Oil pressure.
    b. Coolant temperature.
    c. Base mounted fuel tank level.
    d. Fuel pressure.
11. Time interval from start-up contact closure until full load capabilities are available.
12. List of at least four installations using major components of the same type furnished for this application:
    a. Include name and telephone number of the persons most familiar with this equipment who can be contracted during the submittal review.
13. Number of cylinders, bore, stroke and piston speed.
14. RPM at 60 Hertz.
15. Size of exhaust outlet.
16. The following gaseous exhaust emissions in grams/BHP-HR and Lbs/BHP-HR:
    a. NOX
    b. HC
    c. CO
    d. Other exhaust emissions as required by the local air quality management district issuing the permit for the engine generator system.
    e. These levels shall be reported at rated speed and load as measured by SAE J177 and J215 recommended practices.
17. Voltage and frequency variation and response time with the step application and removal of 25 percent, 50 percent, 75 percent, and 100 percent of resistive load maximum.
18. Battery discharge ampere ratings at the 8 hour rate and the 1 minute rate to 1.75 volts per cell.
19. Certified published engine horsepower curves showing manufacturer's engine rating for generator set standby and prime power application.
20. Start battery catalog number and descriptive bulletin.
21. Displacement in cubic inches.
22. Compression ratio.
23. Recommended spare parts.
24. Space and ambient temperature requirements for the engine control panel.
25. Manufacturer of:
    a. Engine.
    b. Generator.
    c. Generator Control Panel.
    d. Radiator.
26. Estimated number of days to ship complete unit.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
    2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Shipping weight of generator set.
5. Rigging Diagram: Shop drawing to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
6. Wiring Diagrams: Power, signal, and control wiring.

D. Manufacturer Seismic Qualification Certification: Submit certification that engine-generator set, vibration isolation devices, batteries, battery racks, accessories, and components will withstand seismic forces as specified in Section 01 81 10. Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Source quality-control test reports.
1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

F. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Manuals," include the following:
1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

G. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with ASME B15.1.

F. Comply with NFPA 37.

G. Comply with NFPA 70.

H. Most of the generator features shall comply with NFPA 110 requirements for Level 2 emergency power supply system. Some of the generator set features listed in this specification shall comply with Level 1 requirements.

I. Comply with UL 2200.

J. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

K. Noise Emission: Comply with a maximum noise level at 76dB(A) at 7 meters due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the environmental conditions as specified in Section 26 00 00 without mechanical or electrical damage or degradation of performance capability. Generators required to meet output kW as shown on Drawings at project elevation.

1.8 COORDINATION

A. Coordinate size and location of concrete bases for package engine generator. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 5 years or 2000 engine hours, whichever occurs first, from date of Substantial Completion of the entire project.

2. All materials and equipment shall be guaranteed against defective materials, design, and workmanship.
3. During the warranty period, make the necessary repairs or replacements on site, where practical.
4. Warranties which mention that the part must be returned to the factory before repair are not acceptable.
5. During the warranty period, the Owner will not accept charges for:
   a. Travel time.
   b. Mileage.
   c. On-site repair labor.
6. Warranty shall list any and all items excluded.
7. If necessary, as determined by the Owner, any repairs must be made on a premium time basis.
8. Warrant base mounted fuel tank and weatherproof, sound attenuating enclosure as covered by the generator set warranty.
9. Gauge system must carry a full 5-year guarantee that provides for a no-charge visit to the site for replacement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Caterpillar; Engine Div.
   2. Onan/Cummins Power Generation; Industrial Business Group.
   3. Detroit/MTU.
   4. Generac.
   5. Kohler.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

C. Capacities and Characteristics:
   1. Power Output Ratings: Nominal ratings as indicated on drawing at 80% power factor, at the elevation specified in section one of this specification. The generator set shall have capacity as required to start and operate facility loads as shown on the drawings.
   2. Output Connections: Three-phase, four wire, Wye connected.
   3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance:
   1. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.

2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
9. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. Fuel: Fuel oil, Grade DF-2.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: The following items are mounted on engine or skid:
1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Engine Fuel System:
1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

E. Coolant Jacket Heater (block heater): Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

F. Governor: Adjustable isochronous, with speed sensing.

G. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
   1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
   2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
   3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
   4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
      a. Rating: Shall be designed to withstand the pressure and temperature of the cooling system, and noncollapsible under vacuum.
      b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

H. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
   1. Minimum sound attenuation of 25 dB at 500 Hz.

I. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

J. Starting System: 12 or 24-Volts electric, with negative ground, depending on engine manufacture requirements.
   1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   3. Cranking Cycle: As required by NFPA 110 level 1.
   4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycles at least twice without recharging.
   5. Battery Cable: Size as recommended by engine manufacturer for cable length required. Include required interconnecting conductors and connection accessories.
   6. Battery Heater: Factory provided, Thermostat controlled, and sized such that the battery shall be able to produce full starting power at the coldest ambient temperature specified in article one of this specification.
   7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
   8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features. If battery charger is in the transfer switch then see specification section 26 36 00:
      a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower

float-charging mode and shall continue to operate in that mode until battery is discharged again.

b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.

e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Provide U.L. 142 label double wall sub base fuel tank of adequate capacity to operate generator 24 hours at full load. Tank shall be of steel construction and installed under the generator. **Provide Sub Base Tank to include C Channel or I beam welded beneath the tank spaced 40 inches apart to accept neoprene pads between support beams and concrete floor**. Tank shall be equipped with normal and emergency venting. Provide all necessary piping for a complete venting system. Venting shall comply with applicable requirements of IFC. Tank openings and overflow protection shall comply with IFC. Tank to be equipped with supply/return lines installed to engine, low fuel level switch, leak detection, and tank heater. Install tank and accessories per applicable codes, standards, and manufacturers requirements.

2.5 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

D. Indicating and Protective Devices and Controls: Indications and alarms can be shown on an electronic digital readout if manufacturer chooses. These shall be as required by NFPA 110 for Level 1 system, and the following:
1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selection.
9. Generator-voltage adjustment.

E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

F. Connection to Owners Monitoring System: Generator controller shall have a factory installed communication card to communicate the following parameters to Owners Monitor System over Ethernet/IP network:
1. Engine high-temperature shutdown.
2. Lube-oil low-pressure shutdown.
3. Overspeed shutdown.
4. Remote emergency-stop shutdown.
5. Engine high-temperature pre-alarm.
6. Lube-oil low-pressure pre-alarm.
7. Fuel tank, low-fuel level.
8. Low coolant level.
9. Over crank shutdown.
10. Coolant low-temperature alarm.
11. Control switch not in auto position.
12. Battery-charger malfunction alarm.
13. Battery low-voltage alarm.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.

4. Mounting: Adjacent to or integrated with control and monitoring panel.
5. Ground Fault Protection: Comply with NFPA 70 for an application which is not critical to human safety.

B. Generator circuit breaker and controller shall be accessible without the use of steps or ladders, etc. Contractor to provide detachable platform with stairs for maintenance access if circuit breaker or controller are not readily accessible from ground level.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Weatherproof sound-attenuated.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

2.8 OUTDOOR GENERATOR-SET WEATHER PROTECTIVE ENCLOSURE

A. Provide U.L listed weatherproof sound attenuated (**76dB at 23 feet**) housing. Sound attenuated panel shall be a part of the exterior walls of the enclosure. All baffles to be housed on the inside of the enclosure **(no turn down hoods allowed**). Housing to be finished inside and out with a rust-inhibiting primer, and then a top coat paint. Side panels to be removable for maintenance and lockable. Provide necessary louvers and exhaust silencer connections.

B. Provide enclosure mounted panelboard, 208V, 3-ph, 60 amps for generator circuits. Enclosure circuits to include:
1. Battery charger.
2. Coolant heater.
3. Enclosure light.
4. Enclosure receptacle.
5. Battery warmer.

2.9 MOTORS

A. General requirements for motors are specified in Division 26 Section "Motors."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.10 ENGINE GENERATOR BASE

A. Support System: Bolt the engine-driven generator to welded steel base with isolation devices that are an integral part of structural support base.

B. Vibration Isolation Devices: Manufacturer shall design generator set vibration isolation devises and install between the generator and the welded steel base or between the base and the fuel tank.
   1. Design of Isolator Pads: The isolator pads shall be engineered to comply with the weight of the generator-set and the seismic requirements referenced in section one of this specification.

C. Mounting Holes: The generator base or base mounted fuel tank shall be provided with mounting holes, so that the generator-set can be anchored to the concrete base.
   1. Anchor Requirements: Manufacturer shall provide drawing showing mounting hole locations and the size of the anchor bolts required to anchor the generator-set.

2.11 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.12 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
   1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
   2. Full load run.
   3. Maximum power.
   4. Voltage regulation.
   5. Transient and steady-state governing.
   6. Single-step load pickup.
   7. Safety shutdown.
   8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
   9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine-generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with vibration isolators having a minimum deflection in accordance with manufacturer recommendations on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is referenced in Division 26 Section “Electrical General Provisions”.

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance. All connections shall be made in accordance with the shop drawings, Manufacturer’s recommendations, and all applicable codes.

B. Ground equipment as noted on drawings and according to Division 26 Section "Grounding and Bonding."

C. Connect wiring as noted on drawings and according to Division 26 Section "Conductors and Cables."

3.4 IDENTIFICATION

A. Identify system components as noted on drawings and according to Division 26 Section "Electrical Identification."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. The tests are listed in the following paragraphs of this article. Report results in writing.
   1. Engine technician must be completely knowledgeable in the operation, maintenance, and start-up of the mechanical system.
   2. Electrical technician must be completely knowledgeable in the operation, maintenance, and start-up of the electrical system.

B. Tests and Inspections:
   1. Perform tests recommended by manufacturer and those tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
   2. Before start-up, inspect the entire installation and all connections, both mechanical and electrical, and ensure that they are proper and consistent with all Drawings and Specifications.
      1. Inspect for physical damage.
      2. Compare nameplate rating and connection with specifications and single line diagram.
      3. Inspect for proper anchorage and grounding. Engine cooling and fuel system integrity shall be verified.
   3. The factory-certified technicians, during the start-up and adjustment period, shall make sure all items furnished are in proper operating condition.
   4. Certify that fuel, lubricating oil, and antifreeze conform to the Manufacturer’s recommendations under the environmental conditions present.
   5. Check accessories that normally function while the equipment is in standby mode for proper operation, before cranking the engine.
      a. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
         1. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
         2. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
         3. Verify acceptance of charge for each element of the battery after discharge.
         4. Verify that measurements are within manufacturer's specifications.
      b. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
      c. Engine heaters.
   6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
   7. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
   8. Exhaust Emissions Test: Comply with applicable government test criteria.

9. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
10. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

F. Load Test: Full-load test the generating system at the site in the presence of the ENGINEER, with the Manufacturer's representative providing the necessary resistive load banks.
1. Loading shall be:
   a. 25% rated for 30 minutes.
   b. 50% rated for 30 minutes.
   c. 75% rated for 30 minutes
   d. 100% rated for 3 hours.
2. Permanently installed load banks supplied as part of the project may be utilized to provide part of the specified load.
3. Record voltage, frequency, load current, oil pressure and coolant temperature during test. Voltage regulation, frequency stability and maximum temperature rise shall be calculated.
4. Measure radiator performance at full load including airflow, air inlet temperature and air outlet temperature.
5. Correct defects that become evident during testing.
6. Measure flows, pressures and temperatures of fuel, coolant, exhaust gas, and radiator air at inlets and outlets to system components.
7. Provide copies of the test reports to the Engineer. In accordance with submittal requirements referenced in section one.
8. Completely fill fuel tank upon completion of Load Test.

G. Phase rotation shall be verified to determine compatibility with load requirements.

H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
1. Engine shutdown features shall be function tested:
   a. Low oil pressure.
   b. Over-temperature.
   c. Over-speed.
   d. Other features as applicable.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.
   1. Report must state that the installation is complete and satisfactory.
   2. List the items requiring additional attention.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's personnel regarding the operation and maintenance of the packaged engine generators. Including any and all special systems installed by them, or installed under their supervision.
   1. Minimum of 8 hours in two 4 hour sessions each.
   2. Supply written handouts during the training period, and these handouts should be suitable for future reference after the training period is completed.

END OF SECTION

SECTION 26 36 00
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:
   1. Automatic transfer switches.

B. Related Sections include the following:
   1. Division 26 Section "Packaged Engine Generator" for the generator specifications that the switch will be used with.
   2. Division 26 Section "Electrical General Provisions".

1.3 SUBMITTALS

A. Furnish complete submittals in accordance with Section 26 00 00.

B. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

C. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
   1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
   2. Manufacturer Seismic Qualification Certification: The manufacturer shall submit certification of compliance that the equipment will withstand the seismic forces defined for this project as outlined in Specification Section 01 81 10.
   3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Qualification Data: For manufacturer.

E. Field quality-control test reports.
   1. Report will show the results of the switch operation during the testing of the generator.
   2. Report shall also show the settings of the control relays in the automatic transfer switch.

F. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
   1. Features and operating sequences, both automatic and manual.
   2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Source Limitations: The Generator supplier shall also supply the automatic transfer switches. The generator supplier shall also be responsible for startup and coordination with the generator. This will also include any site testing that is required by the manufacturer's representative.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA ICS 1.

E. Comply with NFPA 70.

F. Comply with NFPA 110.

G. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Transfer Switch shall be supplied with the generator. The local generator representative shall be responsible for startup and warranty service of the transfer switch.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Automatic Transfer Switches:
      a. Caterpillar; Engine Div.

b. Onan/Cummins Power Generation; Industrial Business Group.
c. Detroit/MTU.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer.
1. Transfer switch shall be rated for the application as shown on the drawings. If the manufacturer does not provide a switch with the exact rating as shown then a switch with the next higher rating shall be used.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

H. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

I. Battery Charger: If generator supplier wants the battery charger in the transfer switch for generator starting batteries. Then comply with the following.
1. Float type rated amperage output to comply with battery manufacturer recommendations.
2. Ammeter to display charging current.
3. Fused ac inputs and dc outputs.

J. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

K. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Electrical Identification."
   1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
   2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

L. Enclosures: General-purpose NEMA 250, Type **1**, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Switching Arrangement: Double-throw type, break before make. Delayed transition.

B. Controls shall be available on door of transfer switch to operate the switch manually.

C. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

D. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.

E. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

F. Automatic Transfer-Switch Features. The following settings are recommendations, if the manufacturer prefers a different setting, then he shall discuss that with the Engineer:
   1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
   2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
   3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
   4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
   5. Test Switch: Simulate normal-source failure.
   6. Switch-Position Pilot Lights: Indicate source to which load is connected.

7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Retransfer to Normal Power Switch: Switch on door of transfer switch to bypass time delay and retransfer switch to normal power if normal power is available.
11. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check the following items for compliance with specified requirements:
    1. Transfer time.
    2. Voltage setting.
    3. Frequency setting.
    4. Time-delay settings.

B. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Concrete Bases: Install transfer switches on 3-1/2 inch raised concrete housekeeping pad, with chamfered edges, unless otherwise indicated, as shown on the Contract Drawings. Comply with requirements for concrete referenced in Division 26 Section “Electrical General Provisions”.

B. Identify components according to Division 26 Section "Electrical Identification."

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Division 26 Section "Grounding and Bonding."

C. Connect wiring according to Division 26 Section "Wire Connections."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
   a. Set field-adjustable intervals and delays, relays, [and engine exerciser clock].
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
   a. Check for electrical continuity of circuits and for short circuits.
   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
   c. Verify that manual transfer warnings are properly placed.
   d. Perform manual transfer operation.
5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
   b. Verify time-delay settings.
   c. Verify pickup and dropout voltages by data readout or inspection of control settings.
   d. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

B. Coordinate tests with tests of generator and run them concurrently.

C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 1 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION

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SECTION 26 43 00
SURGE PROTECTIVE DEVICES (SPDS)

PART 1 – GENERAL

1.1 SUMMARY

A. Scope

1. The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings

B. Related Sections

1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.
2. Division 26 Section "Electrical General Provisions".

1.2 REFERENCE STANDARDS

A. Institute of Electrical and Electronic Engineers (IEEE)

1.	IEEE C62.41.1 -2002	Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits
2.	IEEE C62.41.2 – 2002	Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
3.	IEEE C62.45 – 2002	Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and less) AC Power Circuits

B. International Electrical Testing Association (NETA)

1.	NETA ATS	Acceptance Testing Specifications for Electrical Power Equipment and Systems

C. National Fire Protection Association (NFPA)

1.	NFPA 70	National Electric Code
2.	NFPA 75	Fire Protection of Information Technology Equipment
3.	NFPA 780	Installation of Lightning Protection Systems

D. Underwriters Laboratories (UL)

1.	ANSI/UL 1283	Electromagnetic Interference Filters

2. ANSI/UL 1449 Surge Protective Devices

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:

1. NFPA - National Electrical Code.
2. Institute of Electrical and Electronic Engineers.
3. National Electrical Testing Association.

B. Specific Definitions:

1. Surge Protective Devices abbreviated as SPDs. (SPDs were previously called out as Transient Voltage Surge Suppressors, TVSS)

1.4 SYSTEM DESCRIPTION

A. Electrical Requirements

1. Nominal system operating voltage, phase, configuration, wire, etc. shall be consistent with the system on which the SPD is to be applied, as indicated on the plans.

1.5 SUBMITTALS

E. Submit the following in accordance with Section 01 33 00 - Submittals.

F. RSN 26 43 00-1, Approval Data:

1. Complete product data:
   a. Unit dimensions.
   b. Weight.
   c. Field connection locations.
   d. Installation instruction details.
   e. Mounting provisions.
2. Verification that the SPD complies with the required ANSI/UL 1449 3rd Edition listing by Underwriters Laboratories (UL).

G. RSN 26 43 00-2, Test Results:

1. Results of inspection and tests performed after installation and prior to startup of SPD.

H. RSN 26 43 00-3, Operation and Maintenance Manuals.

1. Submit in accordance with Section 01 78 39 – Project Record Documents.

I. RSN 26 43 00-4, Spare Parts List:
Submit in accordance with Section 01 78 39 – Project Record Documents

1.6 QUALITY ASSURANCE

A. Nominal system operating voltage, phase, configuration, wire, etc. shall be consistent with the system on which the SPD is to be applied, as indicated on the plans.

B. The system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:
1. IEEE C62.41.1
2. IEEE C62.41.2
3. IEEE C62.45
4. NFPA 70
5. NFPA 75
6. NFPA 780
7. ANSI/UL 1449
8. ANSI/UL 1283

1.7 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.

1.8 WARRANTY

A. The manufacturer shall provide a full ten-year warranty in materials or workmanship from date of shipment against any part failure when installed in compliance with manufacturer's written instructions, UL Listing requirements, and any applicable national, state or local electrical codes.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Same manufacturer as distribution equipment where surge device is installed.

2.2 VOLTAGE SURGE SUPPRESSION – GENERAL

A. Electrical Requirements

1. Unit Operating Voltage: Refer to drawings for operating voltage and unit configuration.

2. Maximum Continuous Operating Voltage (MCOV): The MCOV shall not be less than 115% of the nominal system operating voltage.

3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.

4. Protection Modes: The SPD must protect all modes of the electrical system being utilized. If the neutral is not utilized in a Wye configured system then the line to neutral and neutral to ground modes are not needed. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

5. SPD Type: All SPDs installed on the line side of the service entrance disconnect shall be of Type 1. SPDs installed on the load side of the service entrance disconnect shall be either Type 1 or Type 2 SPDs.

6. Short Circuit Current Rating (SCCR): Per NEC 285.6, the short circuit current rating of the SPD shall be equal to or greater than the available short circuit current at the point on the system where installed.

7. Nominal Discharge Current ($I_{(n)}$): All SPDs located at the service entrance of the distribution system shall have a 20kA $I_{(n)}$ rating regardless of their SPD type (includes Types 1 and 2) or operating voltage. All other SPDs located downstream of the service entrance shall have an $I_{(n)}$ rating of not less than 10KA.

8. ANSI/UL 1449 Voltage Protection Rating (VPR): The maximum ANSI/UL 1449 VPR for grounded WYE configured circuits shall not exceed that specified in the following table:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	800	1200	1500
L-L	1200	2000	2500

9. ANSI/UL 1449 Voltage Protection Rating (VPR): The maximum ANSI/UL 1449 VPR for delta configured circuits shall not exceed that specified in the following table:

Modes	240D	480D	600D
L-G; N-G	1200	2000	2500

B. SPD Design

1. Maintenance Free Design: The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

2. Balanced Suppression Platform: The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance.

3. Electrical Noise Filter: Each unit shall include a high-performance EMI/RFI noise rejection filter.

4. Internal Fusing: The SPD shall be designed in a way that it will take itself off-line before any damaging external effects to the suppressor or surroundings occur.

5. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:
   a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
      1) The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.
   b. Remote Status Monitor – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.

   c. Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.
   d. Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed.

6. Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly.

2.3 SYSTEM APPLICATION

A. The main SPD application covered under this section is service entrance locations such as for switchboards, switchgear, and MCCs. Also if indicated on the drawings the application could include high exposure roof top locations and branch locations.

B. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
CATEGORY	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	240 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

2.4 ENCLOSURES

A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:

1. NEMA 1 – Constructed of a polymer (units integrated within electrical assemblies) or steel (sidemount units only), intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects (falling dirt).
2. NEMA 4 – Constructed of steel intended for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure. (sidemount units only)

3. NEMA 4X – Constructed of stainless steel providing the same level of protection as the NEMA 4 enclosure with the addition of corrosion protection. (sidemount units only)

4. NEMA 12 – Constructed (with knockouts) for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and flyings); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing).

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install SPD devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install SPD devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide a circuit breaker as a dedicated disconnecting means for the SPD. The circuit breaker shall have the number of poles required to match the power system, so that all hot legs are disconnected at one time. The circuit breaker shall be rated at 30 Amps or in accordance with the manufacturer recommendations.

C. Special Techniques

1. Twist the SPD input conductors together to reduce input conductor inductance.
2. Follow the SPD manufacturer's recommended installation practices as found in the installation, operation and maintenance manual and comply with all applicable codes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
2. After installing SPD devices but before electrical circuitry has been energized, test for compliance with requirements.
3. Complete startup checks according to manufacturer's written instructions.

B. SPD device will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Do not energize or connect computer equipment or other sensitive equipment to their sources until SPD devices are installed and connected.

B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to maintain SPD devices

END OF SECTION

SECTION 26 50 00
LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the general requirements for luminaries and light poles.

B. Related Sections - Contract documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.2 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
1. National Electrical Code.
2. Institute of Electrical and Electronic Engineers.
3. National Fire Protection Association.
4. Illuminating Engineering Society.

1.3 SYSTEM DESCRIPTION

A. The Contractor shall furnish and install luminaries and accessories for all lighting systems, complete and operable, all in accordance with the requirements of the contract documents.

B. Individual luminaire types are identified in the plans and on the luminaire schedule.

1.4 SUBMITTALS

A. Furnish complete submittals in accordance with Division 26, Section 26 00 00 “Electrical General Provisions.”

B. Product Data

1. Catalog literature for each luminaire specified, cross-referenced to the luminaire type found on the luminaire schedule in the plans.

    a. Each such submittal shall clearly describe:
        1) Materials.
        2) Type of diffuser.
        3) Hardware.
        4) Gasketing.
        5) Reflector.
        6) Chassis.
        7) Finish.
        8) Ballast.

2. Complete literature for each luminaire substitutions.

   a. Submittals for luminaries shall be sufficient for competent comparison of the proposed luminaire to the originally specified luminaire.
      1) Photometric data shall include coefficients of utilization, average brightness, candle power distribution curves, and lumen output chart.
   b. Substitutions for specified luminaires shall be based upon quality of construction, light distribution, appearance and maintenance.

3. Support method shall be submitted for interior fixtures weighing over 50 pounds.

4. Ballast catalog data indicating lamp wattage, input watts, sound rating, power factor, and type of ballast. Data for outdoor ballast shall include low temperature starting characteristics.

5. Photocell data submittal shall indicate switching capacity, the means of adjusting the lighting pickup level, and enclosure.

6. Pole-mounted luminaries, including complete data on the pole material, finish, handholes, anchoring, and fixture attachment.

7. Pole height, dimensions, bolt hole circle layout, light supporting rating, and wind withstand rating based on effective area of luminaries, and hardware.

C. Calculations

1. Provide mounting details for indoor lights with calculations showing that the installation meets the seismic requirements of the site.

2. Calculations and design must be made by and stamped by a registered professional engineer, registered in the state where the project is being constructed. In light of the fact that this design is being provided by a professional engineer, the submittal will be reviewed for form and content but not reviewed for technical completeness, methods, or calculations.

D. Record Drawings

1. The luminaire schedule in the plans must be updated to reflect the acceptable substitutions, after the substitution has been reviewed and accepted by the Engineer.

1.5 QUALITY ASSURANCE

A. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the referenced portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section.

1. National Electric Code.

2. Underwriters Laboratories.
3. ANSI C82.1 - Specifications for Fluorescent Lamp Ballasts.
4. ANSI C84.4 - Specifications for High-Intensity-Discharge Lamp Ballasts (Multiple Supply Type).
5. Standards of the Certified Ballast Manufacturer's Association.
6. Illuminating Engineering Society (IES).

1.6 DELIVERY, STORAGE, AND HANDLING

A. Luminaries shall be stored in their original cartons from the manufacturers until the time of installation.

B. Luminaire poles shall be stored on blocks above grade until the time of installation.

1.7 PROJECT/SITE CONDITIONS

A. Seismic and wind withstand ratings in accordance with Division 26, Section 26 00 00.

1.8 SEQUENCING AND SCHEDULING

A. Exterior lighting system operation shall be demonstrated during the hours of darkness.

B. Interior lighting system operation shall be demonstrated and witnessed by the Owner and Engineer. This shall include demonstration of all lighting control panels, dimmer switches, and occupancy sensors.

C. Lighting demonstration shall occur within 2 weeks prior to project acceptance.

1.9 WARRANTY

A. The Contractor shall warrant all luminaries, ballasts, and lamps for a minimum period of one (1) year from substantial completion unless otherwise specified by the General Conditions.

1. Furnish, and replace any defective equipment during that period at no charge to the Owner.
2. Said warranty shall be independent of any manufacturer infant mortality or normal failure statistics.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Pre-approved manufacturers are indicated on the luminaire schedule, and in notes on the drawings.

1. This selection of manufacturer's is not intended to be overly restrictive, and the Contractor may make substitutions from the manufacturers listed in the luminaire schedule to offer a more advantageous luminaire package.

2. The lighting design and luminaire selection has been based upon the photometrics of the identified luminaries. It is the Contractor's responsibility to ensure and prove to the Engineer at time of submittal that any substitutions meet the quality and photometric requirements of the original design.
3. The Engineer shall make final determination if proposed substitutes are acceptable.
4. The Contractor shall furnish the identified luminaries at no additional cost to the Owner for any luminaire substitutions that in the sole opinion of the Engineer, are not acceptable.

2.2 EQUIPMENT

A. Luminaries – General

1. All luminaries shall be pre-wired with leads of 18-AWG, minimum, for connection to building circuits.
2. In general, the luminaries furnished shall be as per the luminaire schedule. The specifications apply to those luminaries not described, or as an addition or supplement to the luminaire schedule.

B. Exterior Luminaries

1. Exterior luminaries, in combination with their mounting pole and bracket, shall be capable of withstanding winds of levels consistent with the levels identified in Section 26 00 00, without damage.
2. In general, the luminaries furnished shall be as per the luminaire schedule. The specifications apply to those luminaries not described, or as an addition or supplement to the luminaire schedule.
3. Exterior luminaries shall have corrosion-resistant hardware and hinged doors or a lens retainer.
4. Luminaries specified to be furnished with integral photo-electrical control shall be of the luminaire manufacturer's standard design.

C. Photo-Electric Cells
1. Photoelectric cells for control of multiple fixtures shall be a self-contained, weatherproof type and shall be provided with time-delay features.

2.3 COMPONENTS

A. Poles in general:

1. As indicated in the luminaire schedule.
2. Anchor bolts:
   a. Hot dip galvanized, and formed from hot rolled carbon steel bar stock, with an "L" bend on one end.
   b. Complete with leveling shims.
3. Anchor base:
   a. Fabricated from structural quality hot rolled carbon steel plate, with a minimum yield strength of 36,000 psi.
   b. Base plate to telescope the pole shaft.

c. Welded top and bottom along the entire perimeter.
d. With slotted bolt holes on the bolt circles, as submitted.

4. Handhole:
   a. Reinforced handhole located approximately eighteen (18) inches above the base.
   b. Complete with steel cover and attachment screws.
   c. With an integral ground connection nut, ½" x 13 UNC welded to the pole for connection to the grounding system.
5. Pole mounted convenience outlet:
   a. Furnish a 120 V, GFCI-protected receptacle integrally mounted in the pole shaft at twenty-four (24) inches above the base. Complete with corrosion resistant and weatherproof cover.
   b. In accordance with Division 26, Section 26 27 26 "Receptacles."

B. LIGHTING CONTROLS

1. Contractor responsible for all set-up, programming, and adjustment for all lighting controls including control panels, dimmers, photo-cells, and occupancy sensors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Special Techniques

1. Luminaries shall be installed plumb and square with building and wall intersections.
   a. Pendant-mounted luminaries which are mounted from sloping ceilings shall be suspended by ball hangers, unless otherwise indicated on the drawings.
   b. Luminaries installed in machinery rooms shall be located after machines have been installed.
2. In all cases, luminaire locations shall be coordinated with work of other trades to prevent obstruction of light from the fixtures.
3. Luminaries shall be installed in accordance with the architectural reflected ceiling drawings.
4. Unless otherwise indicated, luminaries shall be centered on ceiling tiles.
5. Luminaries weighing more than 25 pounds shall be supported independently of the outlet box.
6. Recessed luminaries shall be installed light-tight to the ceiling and shall be provided with auxiliary safety supports attached directly to the building structure.
   a. Said safety supports shall consist of #12 AWG, soft drawn galvanized wire.
7. Luminaries installed in suspended grid ceilings shall be supported independently of the grid.
8. All luminaries installed in suspended grid ceilings shall be held in place with seismic restraint clips.

B. Lighting Poles

1. Poles shall be set on anchor bolts and secured with double nuts on each bolt.
2. After luminaire has been leveled and plumbed, the pole base shall be dry-packed.
3. Poles that are specified as hinged shall have one pole lowering winch furnished for all of the poles.

3.2 ADJUSTING

A. All outdoor luminaries shall be aimed after installation during dark evening hours as directed by the Engineer.

3.3 CLEANING

A. Lenses, diffusers, and reflectors shall be cleaned just prior to the time specified for the system demonstrations.

B. Luminaire trim, poles, and support brackets where finish has been damaged, shall be refinished.

C. All luminaries used during construction for construction lighting shall be cleaned, the lamps shall be replaced, and the used lamps returned to the Owner.

3.4 DEMONSTRATION

A. Exterior lighting system operation shall be observed to indicate that fixtures are properly focused, photo-cell operation is correct, and that switching functions as intended in accordance with paragraph 1.8 of this Section.

B. Similar requirements shall apply to interior lighting.

C. Through demonstration, the Contractor shall also verify that panel schedules properly indicate the lighting outlets connected to each circuit.

D. Lighting demonstration shall occur in accordance with paragraph 1.09 of this Section.

3.5 SCHEDULES

A. Refer to the Luminaire Schedules as found in the plans.

END OF SECTION

SECTION 26 50 10
LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes lightning protection for the following buildings:

1. Water treatment plant.

B. Roof types:

1. Standing seam steel metal roof and membrane.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For air terminals and mounting accessories.

1. Layout of the lightning protection system, along with details of the components to be used in the installation.
2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

C. Qualification Data: For qualified Designer, Installer and manufacturer. Include data on listing or certification by UL.

D. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

E. Field quality-control reports.

F. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.

G. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:

1. Ground rods.
2. Ground loop conductor.

1.4 QUALITY ASSURANCE

A. Designer and Installer Qualifications: Certified by UL or LPI, trained and approved for installation of units required for this Project. The designer and installer shall be:

1. VFC INC.
2. OR Approved alternate.

B. System Certificate:

1. UL Master Label.
2. OR; LPI System Certificate.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.5 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures, snow and ice melting heat tape and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

1.6 SYSTEM DESCRIPTION

A. The entire lightning protection system shall be designed and installed in accordance with:

1. Lightning Protection Institute (LPI) Standard #175
2. National Fire Protection Assoc. (NFPA) Document #780
3. Underwriters Laboratories, Inc. (U/L) Standard #96A
4. NEC

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96 and NFPA 780.

B. Designer and Installer shall be:

1. VFC INC.
2. OR Approved alternate.

C. Roof-Mounted Air Terminals: NFPA 780, Class I, copper unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ERICO International Corporation.

b. Heary Bros. Lightning Protection Co. Inc.
c. Harger, Inc.
d. Lyncole
e. Robbins Lightning, Inc.
f. Thompson Lightning Protection, Inc.

D. Main and Bonding Conductors: Copper.

E. Ground Loop Conductor: The same size and type as the main conductor except tinned.

F. Ground Rods: Copper-clad steel, 5/8 inch diameter by 96 inches long.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design and Install lightning protection components and systems according to article 1.6 above.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.

C. Conceal the following conductors:

1. System conductors.
2. Down conductors.
3. Interior conductors.
4. Conductors within normal view of exterior locations at grade within 200 feet (60 m) of building.

D. The lighting protection system shall be grounded to the building ground ring.

E. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. Notify Engineer at least 48 hours in advance of inspection before concealing lightning protection components.

B. The contractor shall furnish an LPI-IP Certificate or a UL Certificate upon completion of the installation.

END OF SECTION

DIVISION 28
ELECTRONIC SAFETY AND SECURITY

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SECTION 28 10 00
ACCESS CONTROL

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. General: The Contractor shall provide access control equipment, complete and operable, in accordance with the Contract Documents.

1.2 DEFINITIONS

A. Access Control System: Comprises a PC Based Host, Access Control Software, Access Controllers and/or Access Control Devices.

B. Access Control Software: Usually contains tools for:
   1. Data acquisition and change.
   2. Card Creation and Layout.
   3. The Control of its own system components.

C. Access Controllers: Machine aided control of access rights and the granting or denying of physical access.

D. Access Control Devices: Refers to doors and readers, and other opening door elements

1.3 SYSTEM DESCRIPTION

A. Access Control System as shown on Drawings. Include all hardware, software, and cabling for a complete and operable access controls system.

1.4 SUBMITTALS

A. Product Data:
   1. Manufacturer's data, user and installation manuals for all equipment and software programs including computer equipment and other equipment required for complete access management.

B. Shop Drawings; include:
   1. System device locations on architectural floor plans.
   2. Full Schematic of system, including wiring information for all devices.

C. Closeout Submittals
   1. User manual.
   2. A bill of material which enumerates devices associated with the digital recorders.
   3. A priced listing of analog spare parts.
   4. System device locations on architectural floor plans.
   5. Wiring and connection diagram.
   6. Maintenance required and maintenance schedule.
   7. Functional test demonstration report.

1.5 QUALITY ASSURANCE

A. Manufacturer:
   1. Minimum of 10 years experience in manufacture and design Access Control Systems and Devices.

B. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standard.

C. Access Control System
   1. Listed by UL specifically for the required loads. Provide evidence of compliance upon request.

D. Installer:
   1. Minimum of 5 years experience installing Access Control Systems.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened, undamaged containers; and unharmed original identification labels.

B. Protect store materials from environmental and temperature conditions following manufacturer's instructions.

C. Handle and operate products and systems according to manufacturer's instructions.

1.7 WARRANTY

A. Provide manufacturer's warranty covering 1 year for the software; and 5 years warranty on Access Control Products to repair and replace defective equipment.

B. Exchanges available for product failures.

1.8 MAINTENANCE

A. Make ordering of new equipment for expansions, replacements, and spare parts available to dealers or end users.

B. Provide factory direct technical support from 8:00 a.m. to 8:00 p.m. via phone and e-mail, or anytime via Web.

PART 2 - PRODUCTS

2.1 ELECTRONIC ACCESS CONTROL AND ALARM MONITORING SYSTEM EQUIPMENT

A. System to be supplied by:
   1. Pro Security Products
      841 East 9400 South
      Sandy, UT 84094

B. Equipment to be supplied as shown on Drawings NO EQUALS.

2.2 ACCESSORIES

A. As required for fully operating system. Supplier required to coordinate all access control hardware with door hardware, locksets, etc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive devices and notify adverse conditions affecting installation or subsequent operation.

B. Do not begin installation until unacceptable conditions are corrected.

3.2 PREPARATION

A. Protect devices from damage during construction.

3.3 INSTALLATION

A. Install controllers and devices in accordance with manufacturer's instructions at locations indicated on the floor drawings plans.

B. Ensure selected location is secure and offers protection from accidental damage.

C. Location must provide reasonable temperature and humidity conditions, free from sources of electrical and electromagnetic interference.

D. Ensure power source is protected against accidental shutoff.

3.4 FIELD QUALITY CONTROL

A. Test snugness of all circuit board mounting screws.

B. Test proper operation of controllers and readers. Present card to the readers to validate if reader functions correctly.

C. Determine and report all problems to the manufacturer's customer service department.

3.5 ADJUSTING

A. Make proper adjustment to controller, extensions and readers for correct operation in accordance with manufacturer's instructions.

3.6 DEMONSTRATION

A. Demonstrate at final inspection that access control system and devices functions properly including a full functional test. Document functional test by providing a completed report to the Owner.

END OF SECTION

DIVISION 31
EARTHWORK

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SECTION 31 10 00
SITE PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section includes all those measures required during the Contractor's initial move onto the site to protect existing fences, structures and associated improvements, streets, and utilities downslope of construction areas from damage due to boulders, trees or other objects dislodged during the construction process: clearing, grubbing and stripping; and regrading of areas to receive embankment fill.

B. The Contractor is required to protect and preserve all things designated to remain. Where Contractor's operation causes damage or injury to trees and plants designated to remain, an arborist or other qualified professional shall be employed by the Contractor, at no additional cost to the Owner, to repair the damage or provide adequate replacement to the Owner's satisfaction where damage is beyond repair.

1.2 SITE INSPECTION

A. Prior to moving onto the Project site, the Contractor shall inspect the site conditions and review maps of the existing plant site and off-site pipeline routes and facilities delineating the Owner's property and right-of-way lines.

B. Contractor shall submit photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site preparation.

C. The Contractor shall identify and accurately locate utilities and other subsurface structural, electrical, and mechanical conditions. Existing conditions shall be incorporated into the record drawings for the project.

1.3 DEFINITIONS

A. The following definitions apply to the Work of this Section:
   1. Clearing is defined as cutting trees, removing fences and posts, removing curbs and other improvements to prepare the site for grubbing and stripping.
   2. Grubbing is defined as the below grade part of clearing to remove roots, small piping, irrigation systems, etc., to prepare the site for stripping.
   3. Stripping is defined as removing a surface layer of soil and organic material, sod, topsoil, and other unsuitable material as defined in Section 31 23 00 – Earthwork, to a depth that earthwork can proceed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Locate and clearly flag trees and vegetation to remain or to be relocated.

D. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
   1. Owner will arrange to shut off indicated utilities when requested by Contractor.
   2. Arrange to shut off indicated utilities with utility companies.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Engineer not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Engineer's written permission.

C. Excavate for and remove underground utilities indicated to be removed.

3.3 PRIMARY PLANT SITE ACCESS

A. Develop any necessary access to the site, including barrier facilities to be installed at the beginning of construction in order to prohibit entry of unauthorized persons.

B. Utility Interference: Where existing utilities interfere with the Work of this Section, notify the Engineer and work around the interferences until a directive is issued.

3.4 CLEARING, GRUBBING, AND STRIPPING

A. All construction areas shall be cleared of grass and weeds to at least a depth of six inches and cleared of structures, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the Work, create a hazard to safety, or impair the Work's subsequent usefulness or obstruct its operation. Loose boulders within 10 feet of the top of cut lines shall be incorporated in landscaping or removed from the site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction, as directed by the Engineer.

B. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove all stumps, roots, buried logs, and all other objectionable material. Debris or waste shall be totally removed if they are found on the site. All objectionable material from the clearing and grubbing process shall be removed from the site and wasted in approved safe locations in compliance with state and federal regulations.

C. The area to be affected by construction that have not been pre-excavated to the subgrade elevation shall be removed and placed in the designated stockpile areas, and/or incorporated into landscaped areas or other nonstructural embankments.

D. For all areas that have not been previously disturbed, including staging areas and temporary construction easements, topsoil-salvaging operation shall immediately follow clearing operations. The area shall be stripped of topsoil to a depth of 8 inches. Unsuitable materials, specified in Section 31 23 00, shall not be considered topsoil. The Contractor shall strip to the depth indicated regardless of the material encountered. All stripped topsoil shall be stockpiled within stripped areas in stockpiles not to exceed 15 feet in height. Vegetation shall be ground or chipped to a mulching consistency and mixed with the stripped soil. Stockpiles shall be placed away from high construction traffic areas and shall be fenced and signed to prevent accidental use as fill prior to topsoil replacement.

E. Upon completion of Work within the construction areas stripped of topsoil, the stored topsoil shall be respread over the disturbed areas. Topsoil shall be spread in about a 6-inch layer. Respread topsoil shall match the existing terrain as much as possible. Interfaces between restored disturbed areas and undisturbed areas shall be chain dragged to eliminate obvious edges. All tracks and equipment marks shall be chain dragged or hand raked away. Replaced topsoil shall be thoroughly watered for dust control upon completion of the respreading operations. Once topsoil replacement has been completed, no vehicles or other motorized equipment shall be allowed to travel on the finished surface.

F. Unless otherwise indicated, native trees larger than three inches in diameter at the base shall not be removed without the Engineer's approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way, if not necessary for the Contractor’s choice of means and methods, shall be arranged with the property owner and be removed and replaced at no increased cost to the Owner.

G. Except in areas to be excavated, holes and other holes resulting from Work of this section shall be backfilled with suitable material in accordance with Section 31 23 00 – Earthwork.

3.5 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner’s property.

END OF SECTION

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SECTION 31 23 00
EARTHWORK

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall perform all earthwork indicated and required for construction of the Work, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

29 CFR 1926	OSHA Safety and Health Regulations for Construction
ASTM C150	Portland Cement
ASTM D 422	Method for Particle-Size Analysis of Soils
ASTM D 1556	Test Method for Density of Soil in Place by the Sand-Cone Method
ASTM D 1557	Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3) (2,700 kN-m/m^3)
ASTM D 1633	Test Method for Compressive Strength of Molded Soil-Cement Cylinders
ASTM D 2419	Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D 2487	Classification of Soils for Engineering Purposes
ASTM D 2901	Test Method for Cement Content of Freshly Mixed Soil Cement
ASTM D 2922	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods
ASTM D 4253	Test Methods for Maximum Index Density of Soils using a Vibratory Table
ASTM D4254	Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D 4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D4832	Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
ASTM D 5971	Practice for Sampling Freshly Mixed Controlled Low Strength Material (CLSM)
ASTM D 6023	Test Method for Unit Weight, Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low Strength Material (CLSM)
ASTM D 6024	Test Method for Ball Drop on Controlled Low Strength Material (CLSM) to Determine Suitability for Load Application
ASTM D 6103	Test Method for Flow Consistency of Controlled Low Strength Material (CLSM)

1.3 CONTRACTOR SUBMITTALS

A. The Contractor's attention is directed to the provisions of Subpart P, 29 CFR 1926 of the OSHA Safety and Health Standards for Construction, which relate to protection of employees in excavations. The Contractor shall submit, for information to the Engineer, the project excavation plan and the name of the Contractor's competent person, prior to commencing any excavation.

B. Submit samples of all materials proposed to be used in the work in accordance with the requirements in Section 01 33 20 – Submittal Procedures. Sample sizes shall be as determined by the testing laboratory.

C. Submit dewatering and water removal plan prior to performing any dewatering or water removal, see Section 31 23 19 – Dewatering.

PART 2 - PRODUCTS

2.1 SUITABLE FILL AND BACKFILL MATERIAL REQUIREMENTS

A. General: Fill, backfill, and embankment materials shall be suitable material.

B. Suitable Materials: Suitable material is defined as selected or processed clean, well graded earth material, sands and gravels free of excessive fines, less than 20 percent rock and boulders larger than 4 inches, grass, roots, brush, vegetation, or other deleterious materials.

C. Fill and backfill materials within 6 inches of any structure or pipe shall be smaller than 1 inch in any dimension.
   1. Suitable materials may be obtained from onsite excavations, may be processed onsite materials, or may be imported. If imported materials are required by this Section or to meet the quantity requirements of the Project, provide the imported materials at no additional expense to the Owner, unless a unit price item is included for imported materials in the bidding schedule. Onsite materials shall be stockpiled and segregated prior to use.

2. The following types of suitable materials are defined:

Type A (Granular Backfill): Crushed rock or gravel, and sand well graded and readily compacted, non-plastic, meeting the following gradation requirements:

Sieve Size	Percentage Passing
1-inch	100
No. 40	15 - 60
No. 200	0 - 15

Type B (Crushed Rock): Manufactured angular, crushed rock, non-plastic, meeting the following gradation requirements:

Sieve Size	Percentage Passing
3/8-inch	100
No. 4	30 - 50
No. 200	0 - 5

Type C (Sand Backfill): Sand non-plastic, meeting the following gradation requirements:

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	80 - 100
No. 10	30-50
No. 40	10-30
No. 200	7 - 15

Squeegee is not acceptable as sand backfill.

Type D (Select Backfill): Suitable material that can be readily compacted and meets the requirements of AASHTO M 145 classification A-1-a, non-plastic, well graded with a maximum particle size of 2 inches.

Sieve Size	Percentage Passing
2-inch	100
No. 10	30-50
No. 40	15-30
No. 200	0 - 15

Type E (Pea Gravel Backfill): Crushed rock or gravel with 100 percent passing a 1/2-inch sieve and not more than 10 percent passing a No. 4 sieve.

Type F (Drainrock): Crushed rock or gravel conforming to one of the following gradation requirements, as shown on the Drawings or approved by the Engineer:

	Percentage Passing		
Sieve Size	3-inch Max.	2-inch Max.	3/4-inch Max.
3-inch	100	-	-
2-inch	90 - 100	100	-
1-1/2 inch	70 - 100	90 – 100	-
3/4 inch	0 - 50	0 – 15	100
1/2-inch	-	-	95 - 100
3/8-inch	0 - 10	0 - 5	70 - 100
No. 4	0 - 25	-	-
No. 8	0 - 5	-	-
No. 200	0 - 3	-	0 - 3

Type G (Type II Aggregate Base): Well-graded, clean, hard, tough, durable, and sound mineral aggregates consisting of crushed stone, or crushed gravel, free of organic matter and contamination from chemical or petroleum products meeting State specification requirements and conforming to the following Table and gradations:

Aggregate Properties			
	Aggregate Class		
	A	**B**	
Dry Rodded Unit Weight	Not less than 75 lb/ft^3		AASHTO T 19
Liquid Limit/Plastic Index	Non-plastic	PI ≤ 6	AASHTO T 89 AASHTO 90
Aggregate Wear	Not to exceed 50 percent		AASHTO T 96
Gradation	Table 2		AASHTO T 11 AASHTO T 27
CBR with a 10 lb surcharge measured at 0.20 inch penetration	70% Minimum	N/A	AASHTO T 193
Two Fractured Faces	50% Min	N/A	AASHTO T 335

Sieve Size	Percentage Passing
1 ½ -inch	100
1-inch	90 - 100
3/4-inch	70 - 85
1/2-inch	65 - 80
3/8-inch	55 - 75
No. 4	40 - 60
No. 16	25 - 40
No. 200	7 - 11

Type H (Graded Drainrock): Graded drainrock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting and drying. The material shall be uniformly graded and shall meet the following gradation requirements:

Sieve Size	Percentage Passing
1-inch	100
3/4 inch	90 - 100
3/8-inch	40 - 100
No. 4	25 - 40
No. 8	18 - 33
No. 30	5 - 15
No. 50	0 - 7
No. 200	0 - 3

Type I: (Levee Material): Clayey sand to sandy clay obtained from off-site borrow sources or from onsite excavations, processed to the extent required to produce a material with a maximum size of 4 inches, well-graded from coarse to fine, and free from roots, sticks, organic matter, concrete, asphalt and other deleterious material. Levee material shall meet the following gradation requirements:

Sieve Size	Percentage Passing
4-inch	100
No. 4	50 - 70
No. 200	30 - 50

Type J (Cement-Treated Backfill): Material which consists of Type F material, or any mixture of Types B, C, G, and H materials which has been cement-treated so that the cement content of the material is not less than 5 percent by weight when tested in accordance with ASTM D 2901. The ultimate compressive strength at 28 days shall be not less than 400 psi when tested in accordance with ASTM D 1633.

Type K (Topsoil): Stockpiled topsoil material which has been obtained at the site by removing soil to a depth as defined in Section 31 10 00 - Site Preparation. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris.

Type M (Aggregate Subbase): Crushed rock aggregate subbase material non-plastic that can be compacted readily by watering and rolling to form a stable base. The sand equivalent value shall not be less than 18 and shall meet one of the following gradation requirements, as shown on the Drawings or approved by the Engineer:

	Percentage Passing	
Sieve Size	3-inch Max.	2-inch Max.
3-inch	100 -	
2-inch	90 - 100	100
1-1/2 inch	-	95 - 100
1-inch	70 - 90	-
No. 4	30 - 65	30 - 65
No. 16	15 - 40	15 - 40
No. 200	2 - 12	2 - 12

Type N (trench plug): Low permeable fill material, a nondispersable clay material having a minimum plasticity index of 10.

Type O (Controlled Low Strength Material (CLSM)): CLSM shall consist of a mixture of portland cement, aggregate, fly ash, water, and approved admixtures conforming to the following requirements:

1. Portland Cement: ASTM C150, Type V.
2. Aggregate: Clean imported sand and gravel or selected material from the excavation, imported material, or a combination thereof as approved by the Engineer. Maximum aggregate size shall be 1 to 3 inches. The soluble sulfate content of aggregate in the mixture shall not exceed 0.3 percent by dry weight.
3. Water: Potable quality.
4. Fly Ash: Class C, ASTM C 618 or approved alternate.
5. The minus 200 sieve fraction shall be nonplastic, as defined by ASTM D 4318. By this standard, a soil is considered nonplastic if either the liquid or plastic limit cannot be determined, or if the plastic limit is equal to or greater than the liquid limit.
6. Proportion the CLSM to be a flowable, nonsegregating, self-consolidating low shrink slurry. The Contractor shall determine the materials and proportions used to meet the requirements of these Specifications.
7. The unconfined compressive strength at 7 days shall be a minimum of 100 psi and a maximum of 300 psi. Contractor shall form a minimum of six test cylinders with proposed materials to confirm design strength and mix design. Four of the cylinders shall be broken at 7 days in conformance with applicable concrete cylinder specifications and results provided to Engineer. The remaining two cylinders shall be broken by Contractor at discretion of Engineer. Initial mix design and cylinder breaks shall be completed at least 21 days prior to use of the material on the jobsite. Final mix approval and use of the material shall not occur prior to confirmation of strength by the cylinder breaks.
8. The temperature of the CLSM discharged into the trench shall be below 90 degrees F.
9. CLSM backfill under concrete structures shall be protected during curing as specified Section 03 30 00 - Cast-in-Place Concrete.
10. CLSM shall be tested in accordance with ASTM D 4832, ASTM D 5971, ASTM D 6023, and ASTM D6103

Type P: (Suitable Trench Backfill): Suitable material that can be readily compacted, with less than 35 percent passing the No. 200 sieve and a plasticity index of 10 or less.

2.2 UNSUITABLE MATERIAL

A. Unsuitable materials include but are not limited to the materials listed below.
   1. Soils which, when classified under ASTM D 2487 - Classification of Soils for Engineering Purposes, fall in the classifications of Pt, OH, CH, MH, or OL.
   2. Soils which cannot be compacted sufficiently to achieve the density indicated for the intended use.
   3. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, slag, and any material which may be classified as hazardous or toxic according to applicable regulations.

4. Soils that contain greater concentrations of chloride or sulfate ions, or have a soil resistivity or pH less than the existing onsite soils.
5. Topsoil, except as allowed below.
6. All other materials that do not specifically meet the materials requirements of this Section or are in excess of the materials required to meet the Project's needs.

B. All unsuitable excavated material shall be disposed off-site.

2.3 USE OF FILL, BACKFILL, AND EMBANKMENT MATERIAL TYPES

A. Use the types of materials as designated herein for all required fill, backfill, and embankment construction hereunder.

B. Where these Specifications conflict with the requirements of any local agency having jurisdiction or with the requirements of a pipe material manufacturer, notify the Engineer immediately. In case of conflict between types of pipe embedment backfills, use the agency-specified backfill material if that material provides a greater degree of support to the pipe, as determined by the Engineer. In case of conflict between types of trench or final backfill types, use the agency-specified backfill material if that material provides the greater in-place density after compaction.

C. Fill and backfill types shall be used in accordance with the following provisions:
1. Embankment fills shall be constructed of Type P material, as defined herein, or any mixture of Type P and Type A through Type F materials.
2. Pipe zone backfill, as defined under "Pipe and Utility Trench Backfill" below, shall consist of the following materials for each pipe material listed below.
    a. Mortar coated pipe, concrete pipe, and uncoated ductile iron pipe shall be provided with Type A or C material in the pipe zone.
    b. Coal tar enamel coated pipe, polyethylene encased pipe, tape wrapped pipe, and other nonmortar coated pipe shall be backfilled with Type C material in the pipe zone.
    c. Plastic pipe and vitrified clay pipe shall be backfilled with Type C material in the pipe zone.
    d. Where pipelines are installed on grades exceeding 4 percent, and where backfill materials are graded such that there is less than 10 percent passing a No. 4 sieve, trench plugs of Type J or N material shall be provided at maximum intervals of 200 feet unless indicated otherwise.
    e. Type O (CLSM) material shall be used in the pipe zone beneath the building structure or where shown on plans, or required by the Engineer for special crossings or other locations, or where otherwise approved.
    f. Type E material will not be allowed for backfill within the pipe zone.
3. Trench zone backfill for pipelines as defined under "Pipe and Utility Trench Backfill" shall be Type D backfill material.
4. Final backfill material for pipelines under paved areas, as defined under "Pipe and Utility Trench Backfill" shall be Type G backfill material. Final backfill under areas not paved shall be the same material as that used for trench backfill.
5. Trench backfill and final backfill for pipelines under structures shall be Type A or B, except where concrete encasement is required by the Contract Documents.

6. Aggregate base materials under pavements shall be Type G material constructed to the thicknesses indicated. Aggregate subbase shall be Type M material.
7. Backfill around structures shall be Type P material, or Types A through Type F materials, or any mixture thereof, except as shown.
8. Backfill materials beneath structures shall be as follows:
    a. Drainrock materials under hydraulic structures or other water retaining structures with underdrain systems shall be Type H material.
    b. Under concrete hydraulic structures or other water retaining structures without underdrain systems, Types F, G or H materials shall be used.
    c. Under structures where groundwater must be removed to allow placement of concrete, Type F material shall be used. Before the Type F material is placed, filter type geotextile fabric shall be placed over the exposed foundation.
    d. Under all other structures, Type F, G or H material shall be used.
9. Backfill used to replace pipeline trench overexcavation shall be a layer of Type F material with a 6-inch top filter layer of Type E material or filter fabric to prevent migration of fines for wet trench conditions or the same material as used for the pipe zone backfill if the trench conditions are not wet.

2.4 PIPELINE MARKING TAPE

A. Metallic Tape: Tape shall be minimum 5.5 mils thick aluminum foil imprinted on one side, encased in high visibility inert polyethylene jacket. Tape shall be a minimum of 6 inches wide. Imprinted lettering shall be 1 inch tall, permanent black, as indicated. Joining clips shall be manufacturer's standard tin or nickel coated. Tape shall be as manufactured by Reef Industries (Terra "D"), Allen (Detectatape), or equal.

B. Plastic Tape: Tape shall be minimum 4-mil thick polyethylene which is impervious to alkalais acids, and chemicals and solvents which are likely in the soil. Tape shall be a minimum of 6 inches wide and lettering shall be 1-inch tall permanent black on a colored background. Tape shall be manufactured by Reef Industries (Terra Tape), Allen (Markline), or equal.

C. Warning Tape: Warning tape manufactured for marking and identifying underground utilities continuously inscribed with a description of utility, colored as follows:
    1. Red; Electric.
    2. Yellow; Gas, oil, steam, and dangerous materials.
    3. Orange: Telephone and other communications.
    4. Blue: Water Systems.
    5. Green: Sewer Systems.

2.5 MATERIALS TESTING

A. All soils testing of samples submitted by the Contractor will be done by a testing laboratory of the Owner's choice and at the Owner's expense. At its discretion, the Engineer may request that the Contractor supply samples for testing of any material used in the work.

B. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Method for Particle-Size Analysis of Soils.

C. Determination of sand equivalent value will be performed using ASTM D 2419 - Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

D. Unified Soil Classification System: References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487. The Contractor shall be bound by all applicable provisions of said ASTM D 2487 in the interpretation of soil classifications.

E. The testing for chloride, sulfate, resistivity, and pH will be done by a testing laboratory of the Owner's choice and at the Owner's expense.

PART 3 - EXECUTION

3.1 EXCAVATION – GENERAL

A. General: Except when specifically provided to the contrary, excavation shall include the removal of all materials of whatever nature encountered, including rock and all obstructions of any nature that would interfere with the proper execution and completion of the Work. The removal of said materials shall conform to the lines and grades indicated or ordered. Unless otherwise indicated, the entire construction site shall be stripped of all vegetation and debris, and such material shall be removed from the site prior to performing any excavation or placing any fill. Furnish, place, and maintain all supports and shoring that may be required for the sides of the excavations. Excavations shall be sloped or otherwise supported in a safe manner in accordance with safety requirements of the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).

B. Maximum Length of Open Trench: The maximum length of open trench in urban and rural areas shall not exceed 500-feet at each pipe installation heading beyond the end of the installed pipeline, or the requirements of the agency with jurisdiction, whichever is lesser.

C. Construction Delays: In the case of any construction delay in excess of five calendar days, whether Contractor or Owner caused, the Contractor shall backfill the excavation, install temporary paving including temporary traffic markings, and restore traffic to pre-construction condition to minimize disruption to traffic and the community at no additional cost to the Owner.

D. Removal and Exclusion of Water: Remove and exclude water, including storm water, groundwater, irrigation water, and wastewater, from all excavations. Dewatering wells, well points, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level at least 2 feet below the bottom of excavations before the excavation work begins at each location. Water shall be removed and excluded until backfilling is complete and all field soils testing has been completed.

3.2 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION

A. Excavation Beneath Structures and Embankments: Except where otherwise indicated for a particular structure or ordered by the Engineer, excavation shall be carried to the grade of the bottom of the footing or slab. Where indicated or ordered, areas beneath structures or fills shall be overexcavated. The subgrade areas beneath embankments shall be excavated to

remove not less than the top 6 inches of native material and where such subgrade is sloped, the native material shall be benched. When such overexcavation is indicated, both overexcavation and subsequent backfill to the required grade shall be performed. When such overexcavation is not indicated but is ordered by the Engineer, such overexcavation and any resulting backfill will be paid for under a separate unit price bid item if such bid item has been established; otherwise payment will be made in accordance with a negotiated price. After the required excavation or overexcavation has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

B. Excavation Beneath Concrete Reservoirs: Excavation under reservoirs shall extend to the bottom of the drainrock layer. After such excavation has been completed, the exposed surface shall be rolled with heavy compaction equipment to 95 percent of maximum density and then graded to provide a reasonably smooth surface for placement of the drainrock. Areas under the reservoir upon which fill is to be placed shall be scarified to a depth of 6 inches, brought to optimum moisture content, and compacted to obtain 95 percent of maximum density with moisture content within plus and minus 2 percent of the optimum moisture content.

C. Excavation Beneath Paved Areas: Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the bottom of the paving thickness. After the required excavation has been completed, the top 12 inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

D. Notification of Engineer: Notify the Engineer at least 3 days in advance of completion of any structure excavation and allow the Engineer a review period of at least 1 day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

3.3 PIPELINE AND UTILITY TRENCH EXCAVATION

A. General: Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with widths as indicated.

B. Trench Bottom: Except when pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe zone. Excavations for pipe bells and welding shall be made as required.

C. Open Trench: The maximum amount of open trench permitted in any one location shall be 500 feet, or the length necessary to accommodate the amount of pipe installed in a single day, whichever is greater]. All trenches shall be fully backfilled at the end of each day or, in lieu thereof, shall be protected in accordance with Section 01 71 50 – Protection of Existing Facilities. The Contractor shall provide temporary 6-foot chain link fencing panels for protection of all open excavations and trenches within public streets, residential areas, and all other locations with the exception of unimproved open areas where excavations and/or pipeline trenches that can be safely sloped in accordance with current OSHA standards to

provide safe access without the use of shoring devices. Temporary fencing panels shall fully enclose open excavations and trenches, and shall remain in place during all non-working hours.

D. Trench Overexcavation: Where trenches are indicated to be overexcavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade of the bottom of the pipe bedding.

E. Overexcavation: When ordered by the Engineer, whether indicated on the Drawings or not, trenches shall be overexcavated beyond the depth and/or width shown. Such overexcavation shall be to the dimensions ordered. The trench shall then be backfilled to the grade of the bottom of the pipe bedding. Overexcavation less than 6 inches below the limits on the Drawings shall be done at no increase in cost to the Owner. When the overexcavation ordered by the Engineer is 6 inches or greater below the limits shown, or wider, additional payment will be made. Said additional payment will be made under separate unit price bid items for overexcavation if such bid items have been established; otherwise payment will be made in accordance with a negotiated price.

F. Where pipelines are to be installed in embankments, fills, or structure backfills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.

G. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield so that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls. If the trench walls cave in or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.

3.4 OVEREXCAVATION NOT ORDERED OR INDICATED

A. Any overexcavation carried below the grade ordered or indicated, shall be backfilled to the required grade with the indicated material and compaction. Such work shall be performed at no additional cost to the Owner.

3.5 BACKFILL – GENERAL

A. Backfill shall not be dropped directly upon any structure or pipe. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed. Backfill around water retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed. Structures shall not be constructed on CLSM backfill until the CLSM has obtained a 7-day minimum cure.

B. Except for drainrock materials being placed in overexcavated areas or trenches, backfill shall be placed after all water is removed from the excavation, and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.

C. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill

and then moving the shield horizontally. Do not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

D. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have all loose sloughing, or caving soil and rock materials removed. All materials disturbed from their intact condition that are 4 inches or larger in least dimension or aggregates of soil material thicker than 4 inches shall be removed from the excavation walls and base prior to placing pipe or any backfill material. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

3.6 PLACING AND SPREADING OF BACKFILL MATERIALS

A. Backfill materials shall be placed and spread evenly in layers. When compaction is achieved using mechanical equipment, the layers shall be evenly spread so that the depth of each uncompacted layer shall not exceed 8 inches of compacted thickness.

B. During spreading, each layer shall be thoroughly mixed as necessary to promote uniformity of material in each layer. Pipe zone backfill materials shall be manually spread around the pipe so that when compacted the pipe zone backfill will provide uniform bearing and side support.

C. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.

D. Where the backfill material moisture content is too high to permit the indicated degree of compaction the material shall be dried or mixed with drier material until the moisture content is satisfactory.

3.7 COMPACTION OF EARTH FILL, BACKFILL, AND EMBANKMENT MATERIALS

A. Each layer of Types A, B, C, G, H, I, and K backfill materials as defined herein, where the material is graded such that at least 10 percent passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content.

B. Each layer of Type E and J backfill materials shall be compacted by means of at least 2 passes from a flat plate vibratory compactor. When such materials are used for pipe zone backfill, vibratory compaction shall be used at the top of the pipe zone or at vertical intervals of 24 inches, whichever is the least distance from the subgrade.

C. Fill on reservoir and structure roofs shall be deposited at least 30 days after the concrete roof slab has been placed. Equipment weighing more than 10,000 pounds when loaded shall not be used on a roof. A roller weighing not more than 8,000 pounds shall be used to compact fill on a roof.

D. Pipe zone backfill materials that are granular, shall be compacted by using vibratory compactors.

E. Equipment weighing more than 10,000 pounds shall not be used closer to structure walls than a horizontal distance equal to the depth of the fill at that time. Hand operated power compaction equipment shall be used where use of heavier equipment is impractical or restricted due to weight limitations.

F. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand operated, vibratory compactors and rollers. After completion of at least 2 feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.

G. Compaction Requirements: The following compaction test requirements shall be in accordance with ASTM D 1557, method C. Compaction shall be obtained with the moisture content within plus or minus 2 percent of the optimum moisture content. Where agency or utility company requirements govern, the highest compaction standards shall apply.

Location or Use of Fill	Percentage of Maximum Density
Pipe embedment backfill for flexible pipe	90
Pipe bedding and overexcavated zones under bedding for flexible pipe, including trench plugs	90
Pipe embedment backfill for steel yard piping	---
Pipe embedment backfill for rigid pipe	90
Pipe zone backfill portion above embedment for rigid pipe	90
Pipe bedding and overexcavated zones under bedding for rigid pipe	90
Final backfill, beneath paved areas or structures	95
Final backfill, not beneath paved areas or structures	85

Trench zone backfill, beneath paved areas and structures, including trench plugs	95
Trench zone backfill, not beneath paved areas or structures, including trench plugs	90
Embankments and fills	90
Embankments and fills beneath paved areas of structures	95
Backfill beneath structures and hydraulic structures	95
Backfill and fill around structures on reservoir or structure roof	90
Topsoil (Type K material)	80
Aggregate base or subbase (Type G or M material)	95

3.8 PLACEMENT OF CLSM (TYPE O MATERIAL)

A. Placement of CLSM is required as trench zone backfill of all underslab piping beneath the building structure. CLSM is required at a minimum to fill the trench from the bottom of the excavation to 12-inches above the top of pipe. Acceptable compacted fill can then be placed up to final grade of the building structure, as specified herein. CLSM is not allowed where pipes cross under the building footing – this requires concrete encasement, see structural drawing details. At the Contractor's discretion, CLSM may be utilized as trench zone backfill in other areas of the project outside the building footprint with Engineer approval.

B. Following placement and anchoring of the pipe, remove all loose soil from trench walls and floor. Remove any unstable soil at the top of the trench, which might fall into the trench during placement of the CLSM.

C. Prior to placement of CLSM, the pipeline steel temperature shall be controlled as specified in Division 33.

D. Deliver the CLSM to the trench in ready mix trucks and utilize pump or chutes to place the CLSM in the trench. Direct CLSM to one side of the pipe, taking care not to displace the pipe

at any time. Continue placing CLSM on one side of the pipe until CLSM has gone under the pipe and up the other side to a depth of 1.5 feet above the pipe bottom. Use at least two hand-held vibrators to continuously liquefy and move CLSM into all voids. Adjust water in mixture to maintain fluid consistency but maintain strength requirements. Continue placing CLSM on both sides of the pipe continuously using two vibrators for every 30 feet of pipe run.

E. Maintain stability of pipe throughout CLSM placement. CLSM will likely require placement in lifts to prevent pipe flotation. No movement of the pipe caused by flotation will be allowed. If any movement occurs, the CLSM material shall be removed and the pipe placed back on line and grade. Any damage to the pipeline system caused by movement of the pipe shall be removed and/or repaired in full conformance with these Contract Documents at no additional cost to the Owner. Remove all sloughed material or other debris from top of previously placed CLSM.

3.9 PIPE AND UTILITY TRENCH BACKFILL

A. Pipe Zone
   1. The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane 6 inches below the bottom surface of the pipe and a plane at a point 12 inches above the top surface of the pipe. The bedding is defined as that portion of pipe zone backfill material between the bottom of the trench and the bottom of the pipe. The embedment is defined as that portion of the pipe zone material between the bedding and a plane at a point 6 inches above the top surface of the pipe.
   2. After compacting the bedding, perform a final trim using a string line for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe. Excavation for pipe bells and welding shall be made as required.
   3. The pipe zone shall be backfilled with the indicated backfill material. Exercise care to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.
   4. If a moveable trench shield is used during backfill operations the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer. Do not displace the pipe or backfill while the shield is being moved.

B. Trench Zone: After the pipe zone backfills have been placed, backfilling of the trench zone may proceed. The trench zone is defined as that portion of the vertical trench cross-section lying between a plane 12 inches above the top surface of the pipe and a plane at a point 18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade.

C. Marking Tape Installation
   1. Continuously install metallic marking tape along the pipe at a depth of 3 feet below finish grade.
   2. Continuously install plastic marking tape along the pipe at the elevation indicated on the Drawings.

D. Final Backfill: Final backfill is all backfill in the trench cross-sectional area within 18 inches of finished grade, or if the trench is under pavement, all backfill within 18 inches of the roadway subgrade.

3.10 FILL AND EMBANKMENT CONSTRUCTION

A. The area where a fill or embankment is to be constructed shall be cleared of all vegetation, roots and foreign material. Following this, the surface shall be scarified to a depth of 6 inches, moisture conditioned, and rolled or otherwise mechanically compacted. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers. Each layer shall be moistened or aerated, as necessary. Unless otherwise approved by the Engineer, the depth of each uncompacted layer shall not exceed 8 inches of compacted thickness. The embankment, fill, and the scarified layer of underlying ground shall be compacted to 95 percent of maximum density under structures and paved areas, and 90 percent of maximum density elsewhere.

B. When an embankment or fill is to be made and compacted against hillsides or fill slopes steeper than 5H:1V, the slopes of hillsides or fills shall be horizontally benched to key the embankment or fill to the underlying ground. A minimum of 12 inches normal to the slope of the hillside or fill shall be removed and recompacted as the embankment or fill is brought up in layers. Material thus cut shall be recompacted along with the new material at no additional cost to the Owner. Hillside or fill slopes 5H:1V or flatter shall be prepared in accordance with Paragraph A, above.

C. Where embankment or structure fills are constructed over pipelines, the first 4 feet of fill over the pipe shall be constructed using light placement and compaction equipment that does not damage the pipe.

D. The finish graded surface of the drainrock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs. Where needed to protect slopes and prevent movement of the drainrock, spray asphalt on the finished drainrock surface in accordance with Section 02460 - A. C. Pavement and Base.

3.11 FIELD TESTING

A. General: All field soils testing will be done by a testing laboratory of the Owner's choice at the Owner's expense except as indicated below.

B. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557. Field density in-place tests will be performed in accordance with ASTM D 1556 or by such other means acceptable to the Engineer.

C. In case the test of the fill or backfill show noncompliance with the required density, perform remedies as may be required to ensure compliance. Subsequent testing to show compliance shall be by a testing laboratory selected by the Owner, paid by the Contractor, at no additional cost to the Owner.

D. Provide test trenches and excavations including excavation, trench support, and groundwater removal for the Owner's field soils testing operations. The trenches and excavations shall be provided at the locations and to the depths required by the Owner. All Work for test trenches and excavations shall be provided at no additional cost to the Owner.

E. Frequency of Testing

1. Backfill around structures and in embankments shall be tested every 300 square ft of each lift of placement.
2. CLSM shall be tested each batch being placed or every 300 cubic yards that is placed.
3. Pipe backfill shall have one test every 80 feet (2 joints) of backfill placed.

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SECTION 31 23 19
DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes construction dewatering.

1.3 PERFORMANCE REQUIREMENTS

A. The Contractor shall provide all labor, materials, and equipment necessary to dewater site excavations, in accordance with the requirement of the Contract Documents.

B. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
   1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
   2. Prevent surface water from entering excavations by grading, dikes, or other means.
   3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
   4. Remove dewatering system if no longer needed.

C. To complete this Work, the Contractor shall secure a Utah Pollution Elimination Discharge System (UPDES) General Permit for Construction Dewatering and Hydrostatic Testing prior to commencing any dewatering work.

D. Dewatering wells with a depth in excess of 30-feet shall be constructed by a Utah licensed well driller. Such wells shall be constructed and abandoned per State of Utah requirements for wells.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

B. Obtain permit from the state of Utah under National Pollutant Discharge Elimination System (UPDES), for storm water discharge from construction sites.

1.5 SUBMITTALS

A. Section 01 33 20 - Submittal Procedures: Requirements for submittals.

B. A Draft Dewatering Plan of the Contractor's proposed dewatering approach is required as part of the bid submittal. The Draft Dewatering Plan should be submitted according to the submittal requirements listed below and technical requirements as outlined in this specification.

C. Shop Drawings:
1. Indicate dewatering system layout, well/sump depths, dewatering pump locations, pipe sizes and capacities, grades, surface water control devices, valves, and water disposal method and location.
2. Indicate primary and standby power system location and capacity.
3. Indicate layout and depth of monitoring wells, piezometers and flow measuring devices for system performance measurement.
4. Include detailed description of dewatering and monitoring system installation procedures and maintenance of equipment.
5. Include description of emergency procedures to follow when problems arise.
6. Review by the Engineer shall not relieve the Contractor of responsibility for the adequacy of the dewatering system to achieve the specified result.

D. Product Data: Submit data for each of the following:
1. Dewatering Pumps: Indicate sizes, capacities, and priming method.
2. Pumping equipment for control of surface water within excavation – if any.

E. Design Data:
1. Indicate design values, analyses, and calculations to support design.
2. Include description and profile of geology, soil, and groundwater conditions.
3. Provide results of any Contractor initiated field investigations, test pits, or pump tests.

F. Field Reports: Test and monitoring reports as specified in Field Quality Control article.

G. Copies of permits related to dewatering, such as but not limited to Storm Water Pollution Preventions Plans, UPDES permits, etc.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
1. Make additional test borings and conduct other exploratory operations necessary for dewatering. Contractor shall perform a field scale pump test prior to preparing the dewatering and shoring plans. The results of the field scale pump test shall be included in the dewatering plan submittal and the shoring plan submittals.
2. The geotechnical report is available upon request.

PART 2 - PRODUCTS

2.1 MONITORING EQUIPMENT

A. Existing Piezometers: To monitor ground water elevation.
   1. The Contractor may utilize the existing piezometers on the site to monitor dewatering efforts.

2.2 WATER TREATMENT

A. Filtration, Tanks, Ponds, etc. as needed to meet water quality standards of UPDES Discharge Permit.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify existing groundwater conditions before starting work.

B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
   1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
   2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

C. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
   1. Maintain free water level below bottom of excavation during construction.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.
   1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.3 SYSTEM OPERATION AND MAINTENANCE

A. Operate dewatering system continuously to maintain groundwater surface below minimum elevation of working surface.

B. Monitor and record daily the ground water surface elevation at all piezometers and monitoring wells.

C. During critical construction periods, provide 24-hour supervision/monitoring of dewatering system by personnel skilled in operation, maintenance, and replacement of system components or an automated system that can call out a local qualified person if a failure occurs.

D. Conduct daily observation of dewatering system and monitoring system. Make required repairs and perform scheduled maintenance.

E. Fill fuel tanks before tanks reach 25 percent capacity.

F. Start emergency generators at least twice each week to check operating condition.

G. When dewatering system cannot control water within excavation, notify ENGINEER and stop excavation work.
   1. Supplement or modify dewatering system and provide other remedial measures to control water within excavation.
   2. Demonstrate modified dewatering system operation complies with performance requirements before resuming excavation operations.

H. Modify dewatering and surface water control systems when operation causes or threatens to cause damage to new construction, existing site improvements, adjacent property, or adjacent water wells.

I. Correct unanticipated pressure conditions affecting dewatering system performance.

3.4 SURFACE WATER CONTROL SYSTEM

A. Provide ditches, berms, and other devices to divert and drain surface water from excavation.

B. Divert surface water and seepage water within excavation areas into sumps and discharge water in accordance with requirements of agencies having jurisdiction.

C. Control and remove unanticipated water seepage into excavation.

END OF SECTION

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SECTION 31 37 00
RIPRAP

PART 1 - GENERAL

1.1 GENERAL

A. This section covers furnishing and placing compacted rock (riprap) materials in accordance with these specifications and in conformity with the lines, grades, and dimension shown on the drawings or as directed by the ENGINEER.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ASTM C 88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 127	Specific Gravity and Absorption of Coarse Aggregate.
ASTM C 535	Standard Test Method for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
ASTM D 5519	Standard Test Method for Particle Size Analysis of Natural and Man-Made Riprap Materials.
AASHTO T 85	Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate
AASHTO T 210	Method of Test for Aggregate Durability Index.

1.3 CONTRACTOR SUBMITTAL

A. At least 30 days before rock is delivered from any source, the contractor shall designate in writing the source from which rock material will be obtained and provide information satisfactory to the ENGINEER that the material meets contract requirements. CONTRACTOR shall provide ENGINEER free access to the source for the purpose of obtaining samples for testing.

B. Rock riprap source locations, processing, haul routes, storage and placement plan.

C. Certification from a certified independent laboratory that the riprap meets the material properties of this specification, if riprap is provided from a source other than noted on the drawings.

D. Furnish submittals in accordance with Section 01 33 20 –Submittal Procedures.

1.4 STORAGE OF MATERIALS

A. Materials shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials.

PART 2 - PRODUCTS

2.1 RIPRAP BEDDING MATERIAL

A. Riprap Bedding material sources shall be approved by the ENGINEER prior to use. Bedding material shall be clean and free from organic matter and free of concrete masonry or concrete pavement. It shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The material shall be uniformity graded and shall conform to the following gradation:

1.

a.	Size	Percentage Passing
b.	3-inch	85 – 100
c.	1 1/2-inch	45 – 75
d.	3/4-inch	10 – 25
e.	No. 200	0 - 5

2.2 RIPRAP

1. Rock materials shall meet the following requirements:
   a. Individual rock fragments shall be fresh, dense, sound, sub-angular to angular and resistant to abrasion, and durable against disintegration under conditions to be met in handing and placing.
   b. Individual rock fragments shall be free from cracks, seams, and other defects that would tend to increase their susceptibility to destruction by water, frost actions, and accelerated weathering.
   c. Riprap sources shall be approved by the ENGINEER prior to use. Concrete masonry or concrete debris may not be used for riprap. Rock shall meet the following gradation limits after it has been placed within the matrix of the compacted rock riprap (dimensions apply to minimum section), in accordance with ASTM D 5519:

COMPACTED ROCK RIPRAP GRADATIONS			
Riprap Designation	%Smaller Than Given Size By Weight	(Inches)	D_{50}** (Inches)
Riprap D_{50} = 12”	70-100 50-70 35-50 2-10	20 16 12 4	12
s** D_{50} = Nominal particle size			

   d. Maximum rock size shall not exceed 2.0 times the D_{50}. Minimum rock size shall be no less than 6-inches.

e. Sand and rock dust shall be less than 3 percent, by weight, of total riprap materials.
f. Neither the breadth nor thickness of any piece of rock shall be less than one-third its length.
g. Rock shall be sub-angular to angular. Rounded boulders and cobbles shall not be used. The greatest dimension of each rock shall not be greater than three times its least dimension.
h. Specific Gravity: not less than 2.5 when tested in accordance with ASTM C127 (Bulk SSD).
i. Weight: Minimum weight of stone shall be 156 lb/ft^3 as tested by AASHTO Test T 85.
j. CONTRACTOR shall submit documented laboratory test results to verify that proposed riprap materials meet all specifications.
k. CONTRACTOR must receive, in writing, approval of proposed off-site riprap source from ENGINEER, prior to placing any materials.
l. CONTRACTOR shall be responsible to process material that will meet these specifications.

PART 3 - EXECUTION

3.1 COMPACTED ROCK (RIPRAP)

A. CONTRACTOR shall provide a small test pile of riprap to the site for inspection and comparison to the gradation required for the project. Test pile results that do not meet the specifications shall be cause for the rock to be rejected. The test pile that meets specification requirements shall be left on the job site as a sample for visual comparison. The test pile rock shall be utilized as part of the last rock riprap to be placed.

B. Prior to placement of filter material, remove brush, trees, round rocks, and other objectionable materials in area where riprap is to be placed. All objectionable material shall be disposed of at a location to be determined by the OWNER. All soft or spongy material shall be removed to the depth as directed by the engineer and replaced with native material. Care shall be taken to preserve and protect utilities which are to remain in service in the location where riprap is to be placed.

C. The subgrade surface on which the geotextile filter fabric will be placed shall be cut or filled and graded to the lines and grades shown on the drawings. When fill to subgrade lines is required, it shall consist of approved material and shall conform to the requirements of the specified class of earthfill. Geotextile filter fabric shall not be placed until the foundation preparation is complete and the subgrade surface has been approved by the ENGINEER.

D. Riprap shall generally be placed starting at the lowest elevations and working upward, taking care not to damage the geotextile filter fabric. Rock shall not be dropped more than 2 feet onto the installed geotextile filter fabric. Riprap shall be placed to the minimum thickness designated on the drawings and shall be positioned in such a manner that will provide uniform distribution of the various sizes of stone and produce a well-keyed, compacted mass of rock with the least practical amount of void space. Riprap shall be placed and compacted with the bucket of a backhoe to the lines and grades shown on the drawings. Placing of riprap

in layers, or by dumping into chutes, or by similar methods likely to cause segregation, will not be permitted. The surface shall be worked as necessary, to produce a reasonably uniform appearance and the required thickness. Some hand placing may be required to provide a neat and uniform surface.

E. Rock riprap shall be placed in a manner that will prevent damage to structures.

F. Hand placed riprap. Rock riprap shall be placed in a manner to prevent damage to structures, pipe or other improvements. Hand placing may be required to prevent damage to facilities.

G. CONTRACTOR shall leave riprap storage/borrow sites in a neat and clean condition, free from rock chips, spalls, and debris from riprap sizing process.

H. CONTRACTOR shall implement good housekeeping measures and best management practices to prevent mud and other material from being tracked or deposited on City and County streets.

END OF SECTION

DIVISION 32
EXTERIOR IMPROVEMENTS

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SECTION 32 12 16
A.C. PAVEMENT AND BASE

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall perform all work associated with A.C. Pavement and Base, as shown and specified herein including all labor, materials, equipment supplies and facilities associated with providing of finished product satisfying all the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

AASHTO M 82	Cut-Back Asphalt (Medium Curing Type)
AASHTO M 140	Emulsified Asphalt
AASHTO M 208	Cationic Emulsified Asphalt
AASHTO M 226	Viscosity Graded Asphalt Cement
ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 692	Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 977	Emulsified Asphalt
ASTM D 1073	Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 1557	Moisture-Density Relations of Soils and Soil - Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in (45-mm) Drop7
ASTM D 2027	Cutback Asphalt (Medium Curing Type)
ASTM D 2397	Cationic Emulsified Asphalt
ASTM D 2726	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures using Saturated Surface-Dry Specimens.
ASTM D 3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3515	Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 20 - Contractor Submittals. Include materials testing reports, job-mix formulas, and other pertinent information satisfactory to the Engineer.

B. Prior to Delivery to Site:
   1. Mix Design: Submit current mix design dated within one year of submittal listing:
      a. Date of mix design
      b. Asphalt cement source, type and chemical composition.
      c. Aggregate gradation target.
      d. Asphalt cement target percentage, dust to asphalt ratio, moisture sensitivity (tensile strength ratio), stability, flow and voids in the bituminous mix.
   2. Before changing mix design, submit new design to Engineer 10-days prior to placing pavement for review and evaluation of changes.
   3. Type and number of compaction and finish rollers.

C. At Delivery: Supply a batch ticket identifying:
   1. Serial Number of ticket.
   2. Date and truck number.
   3. Job name, location and mix identification.
   4. Type, grade and weight of asphalt.
   5. Type, grade and weight of aggregate.
   6. Mix design method.

D. Trial Batch: Before placing any paving material, a testing laboratory acceptable to the Engineer shall prepare a trial batch of asphalt concrete for each job-mix formula to be used by the Contractor for the work. The trial batch shall be prepared using the aggregates and asphalt cement proposed by the Contractor, and approved by the Engineer. The compacted trial batch shall provide a basis for computing the voids ratio, provide an indication of the optimum asphalt content, and establish a basis for controlling compaction during construction. The cost of not more than two laboratory trial batch tests will be paid by the Owner but the Contractor shall furnish the materials at no cost to the Owner. Any additional trial batch testing required shall be performed at the expense of the Contractor.

1.4 QUALITY ASSURANCE

A. Use a laboratory that follows and complies with ASTM D 3666.

B. Do not change aggregate source, asphalt source or mix design without Engineer's prior written approval.

C. Reject product and work that does not meet the requirements of this Section.

D. Remove product that is found to be defective after installation and install acceptable product at no additional cost to the Owner.

E. Foreman of paving crew shall have completed at least five projects of similar size and nature.

1.5 WEATHER

A. Do not pave until air temperature is 45 degrees F and rising.

B. Cease paving if air temperature falls below 50 degrees F.

C. Do not pave if surface is wet or if rain, snow or other precipitation is expected.

D. Do not pave if wind or ground cools the mix material before compaction.

1.6 ACCEPETANCE

A. General: Acceptance is by lot.

B. Materials:
   1. Lot is one day's production.
   2. At the source:
      a. Aggregate: Verify gradation. Collect sample form the conveyor belt or stockpile if belt is not accessible.
      b. Paving Asphalt: Asphalt shall meet the requirements of this section and shall satisfy the limits identified in the Utah Department of Transportation's "Manual of Instructions – Part 8 Materials"
      c. Mix Temperature shall not exceed 325 degrees F in the transport vehicle.
   3. At the Site:
      a. A sub-lot is 500 tons.
      b. Obtain one random sample per sub-lot behind the paver before compaction or at locations exhibiting non-uniform appearance.
   4. At the Laboratory:
      a. Air voids shall be evaluated on the basis of laboratory compacted samples.
      b. Dust to asphalt ratio.
      c. Asphalt content and aggregate gradation.
   5. If material does not meet any requirement of the specification, the Engineer may direct that the sub-lot be removed and replace with a material meeting the specification requirements at no additional cost to the Owner.

C. Installation:
   1. Observation of Contractor's field quality control testing does not constitute acceptance.
   2. Opening a paved surface to traffic does not constitute acceptance:
   3. Reject any mixes exceeding 325 degree F in transport vehicle.
      a. Dispose of cold mix in paver hopper as thin spread underlay.
   4. Grade, Cross Slope: Verify that tolerance is not exceeded.
   5. Compaction:
      a. For compaction a lot is 1,000 square yards or any part thereof.
      b. Core Density: A lot is acceptable if the average core density does relative to ASTM D 2041 is 93 percent, with no individual test less than 89 percent.
      c. At least two test locations shall be sampled per ASTM D 3665 and three core samples shall be collected per each test location per ASTM D 5361. Core samples shall be full depth.

d. Cores shall be tested per ASTM D 2725 for core density and ASTM D 2041 (Rice) for maximum theoretical density.
e. Other non-destructive testing methods may be used during placement to aid in establishing a rolling pattern and determining the required compaction effort. However, density acceptance will be by core densities.

6. Thickness:
   a. For thickness a lot is 1,000 square yards or any part thereof.
   b. Core Thickness: A lot is acceptable if the average core thickness is not less than 0.25 inches less than the specified thickness.
   c. At least two test locations shall be sampled per ASTM D 3665 and three core samples shall be collected per each test location per ASTM D 5361. Core samples shall be full depth.
   d. Cores shall be tested per ASTM D 3549 for thickness.
7. Lots that are not acceptable may be rejected and the Engineer may direct that the lot be removed and replaced at no additional cost to the Owner.

PART 2 - PART 2 – PRODUCTS

2.1 UNTREATED BASE COURSE

A. The untreated base course shall consist of select material, either natural or crushed and shall be graded as follows:

Sieve Size	Gradation Ideal Gradation (% Passing)
1-1/2 inch	100
3/4 inch	70-85
3/8-inch	55-75
No. 4 sieve	40-65
No. 16 sieve	25-40
No. 200 sieve	7-11

2.2 TACK COAT

A. Tack coat shall be emulsified asphalt Grade SS-1 or SS-1h, CSS-1 or CSS-1h diluted with one part water to one part emulsified asphalt, undiluted asphalt Grade RS-1 or CRS-1, or paving asphalt Grade AR-1000. Emulsified asphalt shall comply with the requirements of AASHTO M 140 (ASTM D 977) or M 208 (ASTM D 2397); paving asphalt shall comply with the requirements of AASHTO M 226 (ASTM D 3381).

2.3 ASPHALT CEMENT (AC)

A. Petroleum Asphalt that complies with table 2 of ASTM D 3381 except as follows:
   1. Delete the loss on heating requirement on the residue from the "Thin-Film Oven Test".

B. Substitute Performance Graded Asphalt Binder (PGAB)
   1. PGAB asphalt meeting the requirements of ASTM D 6373 may be substituted for AC asphalt cement as follows:
      a. AC - 10 – PGAB 58-28 with no more than 15% RAP.

2.4 AGGREGATE

A. Aggregate shall be clean, hard, durable, angular and sound consisting of crushed stone, crushed slag, crushed gravel, sand, or a combination of two or more of these materials.

B. Source Suitability: Use the following requirements to determine the suitability of the aggregate source and not for project control.
   1. Coarse Aggregates:
      a. Angularity (fractured faces), ASTM D 5281: 50 percent maximum by weight of particles with at least 2 fractured faces.
      b. Hardness (toughness), ASTM C 131: 40 percent minimum wear of aggregate retained above the No. 4 sieve unless specific aggregates having higher values are known to be satisfactory.
      c. Flat or elongated particles, ASTM D 4791: 20 percent maximum retained above the 3/8 inch sieve has a 3:1 length to width ratio.
   2. Fine Aggregates:
      a. Friable Particles, ASTM C 142: 2 percent maximum passing the No. 4 sieve.
      b. Plasticity, ASTM D 4318: Aggregate passing the no. 40 sieve shall be non-plastic even when filler material is added to the aggregate.
         1) Liquid Limit: Less than 25
         2) Plastic Limit: Less than 6

C. Combinations of aggregates having a history of polishing shall not be used in surface courses.

2.5 ADMIXTURES

A. Mineral filler shall comply with ASTM D 242.

B. Antistrip shall be heat stable cement slurry of lime slurry.

2.6 MIX DESIGN

A. Material Designation:
   1. Asphalt Cement shall be PG-58-28.
   2. Aggregate gradation shall be DM-3/4.
   3. Traffic Classification shall be medium.

B. Design Aggregate Gradation: The job-mix formula for the asphalt-aggregate surface course mixture shall be within the following gradation limits as percent passing by weight, ASTM C 136:

Aggregate Gradations				
Sieve Size	DM-1	DM-3/4N	DM-3/4	DM-1/2
1 inch	100			
3/4 inch		100	100	
1/2 inch	75-91	74-99		100
3/8 inch		69-91	75-91	
No. 4	47-61	49-65	46-62	60-80
No. 8		33-47		
No. 16	23-33	21-35	22-34	28-42

No. 50	12-22	6-18	11-23	11-23
No. 200	3-7	2-6	3-7	3-7

1. Dry-rodded Unit weight per ASTM C 29 shall be a minimum of 75 pounds per cubic foot.
2. Weight Loss or soundness per ASTM C 88 shall be a maximum of 16 percent using sodium sulfate.
3. Clay Content or cleanliness per ASTM D 2419shall be determined by the sand equivalent value after passing through the dryer or prior to the drum mixer at the following levels:
   a. 45 percent minimum for Medium Traffic Classification
   b. 60 percent minimum for Heavy Traffic Classification.

C. Design Mixture Test Criteria: Use the Marshall volumetric mix design, AI MS-2: price and payment procedures

Mix Design Criteria			
Criteria	Traffic Classification		
	Light	Medium	Heavy
Number of Compaction Blows	35	50	75
Stability, lbs. (minimum), ASTM D 5581	750	1200	1800
Flow, in 0.01 inch units, ASTM D 5581	10-18		
Voids in Mineral Aggregate (VMA), percent min., ASTM D 3203 Nominal Maximum Particle Size 1” 3/4” 1/2” 3/8”	 13 14 15 16.5		
Voids in Bituminous Mix (percent)	3-5		
Dust to Asphalt Ratio	0.8 – 1.6		
Moisture Sensitivity, ASTM D 4867	>0.8 with freeze thaw conditioning and test specimen compacted at 6-8 percent air voids		

Notes
Traffic Classifications:
Light – Parking lots, driveways, light traffic residential streets, light traffic farm roads. (ESAL $<10^4$ per year)
Medium – Residential streets, rural farm and residential roads (Class II); Urban minor collector streets, rural minor collector roads (Class III). (10^4<ESAL<10^6 per year)
Heavy – Urban Minor arterial and light industrial streets, rural major collector and minor arterial highways (Class IV); Urban major arterial and heavy industrial streets, freeways, expressways, arterial highways, rural interstate, and other principal arterial highways (Class V). (ESAL > 10^6 per year)

2.7 SOURCE QUALITY CONTROL

A. General: Supplier shall randomly collect samples per ASTM D 3665. The same sample point shall be used for all samples of a particular material.
   1. Aggregate sampling shall be per ASTM D 75.
   2. Asphalt Cement sampling shall be per ASTM D 140.

B. Asphalt-aggregate mix shall be sampled per ASTM D 979 and test for:
   1. Air Voids per ASTM D 3203.
   2. Paving Asphalt Content per ASTM D 6307.
   3. Aggregate Gradation per ASTOM D 5444
   4. Tensile strength of bitumen-aggregate mixtures per ASTM D 4867.

C. Mixing plant shall meet the requirements of ASTM D 3515.

2.8 PAVEMENT MARKING PAINT

A. Pavement marking paint shall be a product specifically formulated for use on asphalt concrete pavement and shall have a proven record of performance and durability. The paint striping materials shall conform with the State of Utah Standard Specifications for Road and Bridge Construction and its addenda.

PART 3 - EXECUTION

3.1 SUBGRADE PREPARATION

A. The subgrade shall be prepared in accordance with geotechnical recommendations and Section 31 23 00 – Earthwork as applicable to roadways and embankments. The surface of the subgrade after compaction shall be hard, uniform, smooth and true to grade and cross-section. Subgrade for pavement shall not vary more than 0.02-foot from the indicated grade and cross section. Subgrade for base material shall not vary more than 0.04-foot from the specified grade and cross section.

3.2 UNTREATED BASE COURSE

A. Untreated base course shall be provided where shown and to the thickness indicated. Imported untreated base course shall be delivered to the job site as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free of pockets of coarse or fine material. Where the required thickness is 6 inches or less, the base materials may be spread and compacted in one layer. Where the required thickness is more than 6 inches; the base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6 inches. The relative compaction of each layer of aggregate base shall be not less than 96 percent of maximum density when measured in accordance with ASTM D 1557 with no test below 92 percent of maximum density. The compacted surface of the finished aggregate shall be hard, uniform, smooth and at any point shall not vary more than 0.02 foot from the specified grade or cross-section.

3.3 TACK COAT

A. A tack coat shall be applied to existing paved surfaces where new asphalt concrete is to be placed on existing pavement. It shall also be applied to the contact surfaces of all cold pavement joints, curbs, gutters, manholes and the like immediately before the adjoining asphalt pavement is placed. Care shall be taken to prevent the application of tack coat material to surfaces that will not be in contact with the new asphalt concrete pavement. Diluted emulsified asphalt shall be applied at the rate of 0.05 to 0.15 gal/sq yd. Undiluted

emulsified asphalt shall be applied at the rate of 0.025 to 0.075 gal/sq yd. Paving asphalt shall be applied at the rate of approximately 0.05 gal/sq yd.

3.4 CONSTRUCTION EQUIPMENT

A. Lay Down Machine shall have tracks when operating on fabrics, geogrids or pavement mats hotter than 180 degrees F.

B. Compactors shall be static or vibratory, steel wheel rollers. Pneumatic tire rollers may be used for intermediate rolling only.

3.5 ASPHALT CONCRETE

A. At the time of delivery to the work site, the temperature of mixture shall not be higher than 320 degrees F, and shall not be less than indicated below:

Minimum Asphalt Concrete Temperature, degrees F						
Air	Compacted Mat Thickness					
Temperature	3/4 inch	1 inch	1-1/2 inch	2 inch	3 inch	4 inch +
45-50	-	-	-	-	280	265
50-59	-	-	-	280	270	255
60-69	-	-	285	275	265	250
70-79	285	285	280	270	265	250
80-89	280	275	270	265	260	250
90+	275	270	265	260	250	250

B. The asphalt concrete shall be evenly spread upon the subgrade or base to such a depth that, after rolling, it will be of the required cross section and grade of the course being constructed.

C. The depositing, distributing, and spreading of the asphalt concrete shall be accomplished in a single, continuous operation by means of a self-propelled mechanical spreading and finishing machine designed especially for that purpose. The machine shall be equipped with a screed or strike-off assembly capable of being accurately regulated and adjusted to distribute a layer of the material to a definite pre-determined thickness. When paving is of a size or in a location that use of a self-propelled machine is impractical, the Engineer may waive the self-propelled requirement.

D. Spreading, once commenced, shall be continued without interruption.

E. The mix shall be compacted immediately after placing. If needed, intermediate rolling with a pneumatic-tired roller shall be done immediately behind the initial rolling. Final rolling shall eliminate marks from previous rolling. In areas too small for the roller, a vibrating plate compactor or a hand tamper shall be used to achieve thorough compaction.

F. Compaction shall be completed before temperature drop to 180 degrees F.

G. Do not leave unsafe butt joints if paving operations stop.

H. Barricade or eliminate fall off edges.

I. Joints

1. Construct joints to have the same texture, density and smoothness as other section of the new pavement course.
2. Clean contact surfaces and apply tack coat. Ensure continuous bond between old and new pavement or between successive day's work.
3. Offset longitudinally joints a minimum of 12 inches in succeeding courses and offset transverse joints a minimum of 6 feet to avoid a vertical joint through more than one course. In the tops course restrict longitudinal joints to either side of the lane lines.
4. Prevent traffic, including construction traffic, from crossing vertical edges. Apply tack coat to vertical edges prior to making another pass with the paver if the mix has cooled to 90 degrees F.

3.6 TOLERANCES

A. Lift thickness shall not be less than 2 times the maximum aggregate size nor more than 3 inches (compacted thickness) or the limits established by the pneumatic or vibratory compactor equipment manufacturer, whichever is less.

B. Upon completion the pavement shall be true to grade and cross-section. When a 10-ft straightedge is laid on the finished surface parallel to the center of the roadway, the surface shall not vary from the edge of the straightedge more than 1/8-in except at intersections or changes of grade. In the transverse direction, the surface shall not vary from the edge of the straightedge more than 1/4-in.

3.7 BITUMINOUS SURFACE PATCHING

A. Where pits are excavated through bituminous surfaced roads, driveways, parking areas, etc., the surface shall be restored and maintained as follows:
1. A temporary gravel surface shall be placed and maintained after the required backfill and compaction of the trench has been accomplished.
2. The gravel shall be placed to such depth as to provide six inches below the pavement and shall be brought flush with the paved surface.
3. The area over trenches to be resurfaced shall be graded and rolled with a roller weighing not less than twelve tons, or with the rear wheels of a five-yard truck loaded to capacity, until the subgrade is firm and unyielding. Mud or other soft or spongy material shall be removed and the void filled with gravel and rolled and tamped thoroughly in layers not exceeding six inches in thickness. The edges of trenches which are broken down during the making of subgrade shall be removed and trimmed neatly before resurfacing.
4. Before any permanent resurfacing is placed, the Contractor shall trim the existing paving to clean, straight lines as nearly parallel to the centerline of the trench as practicable.
5. Existing bituminous paving shall be cut back a minimum of six inches beyond the limits of any excavation of cave-in along the trench so that the edges of the new paving will rest on at least six inches of undisturbed soil.
6. As soon as is practical, weather permitting, the bituminous surface shall be restored by standard paving practices to the thickness specified herein.
7. Pavement restoration shall include tacking of pavement of edges and subbase with MC 70-250 bituminous material and placing rolling plant hot mix bituminous material to the level of the adjacent pavement surfaces.

3.8 PROTECTION AND REPAIR

A. General: All work is at no additional expense to the Owner.

B. Protection:
   1. Protect all structures, including curb, gutter, sidewalks, street fixtures, delineators, signs, guard rails and guide posts.
   2. Remove all spatter, over-coat or mar.
   3. Do not discharge bituminous materials into borrow pits, roadside ditches, gutters or other areas.
   4. Protect hot pavement from traffic until mixture has cooled enough not to become marked.
   5. Protect neighborhood, storm drains and downstream wetland and fish habitats.

C. Repair
   1. When thickness is deficient, place additional material over deficient areas. Do not skin patch. If necessary, mill for inlay.
   2. Repair defective seams, edges and joints.
   3. Remove and replace unacceptable paving.

3.9 PAVEMENT MARKING

A. Pavement marking paint shall be applied where indicated only when the pavement surface is dry and clean, and when the air temperature is above 40 degrees F. Pavement marking shall commence no sooner than 21 days after completion of pavement installation. All equipment used in the application of pavement marking shall produce stripes and markings of uniform quality with clean and well-defined edges that conform to the details and dimensions shown. Drips, overspray, improper markings, and paint material tracked by traffic shall be immediately removed from the pavement surface by methods previously reviewed by the Engineer.

END OF SECTION

SECTION 32 13 73
PAVEMENT JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes joint sealants for exterior site concrete pavement work including parking lots, ,driveways, sidewalks, curbs, curb and gutters, waterways, etc:
   1. Joint Void-former
   2. Cold-applied joint sealants.
   3. Hot-applied joint sealants.

B. Related Sections:
   1. Division 32 Section 32 12 16 - "Asphalt Cement Pavement and Base" for constructing joints between concrete and asphalt pavement.
   2. Division 32 Section 32 17 73 - "Driveways, Sidewalks, Curbs, Gutters, and Other Concrete Flatwork". for constructing joints in concrete pavement
   3. Division 7 Section 07 92 00 - "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

1.3 SUBMITTALS

A. Product Data: Provide Manufactures product data and sample for each joint-sealant product indicated.

B. Product Certificates: For each type of joint sealant and accessory, from manufacturer.

C. Manufacturer's instructions for joint preparation, type of cleaning and installation for each type of joint sealant.

1.4 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
   2. When joint substrates are wet.
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.5 SYSTEM PERFORMANCE

A. Pavement joints include longitudinal and transverse expansion joints, isolation joints, contraction joints, and crack control joints.

B. Provide joint sealants that maintain watertight and airtight continuous seals.

1.6 QUALITY ASSURANCE

A. Installation of joint systems shall follow manufacturer's published instructions.

B. For cold applied joint sealant installation, use installers that are approved by the joint sealant supplier. Provide written proof on sealant supplier's approval.

C. Obtain joint sealing materials from a single manufacturer for each different product required.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site in original, unopened containers or bundles with labels identifying manufacturer, product name and designation, color, expiration period for use, pot life, cure time, and mixing instructions for multi-component materials.

B. Store and handle materials in compliance with manufacturer's recommendations to prevent deterioration; or damage due to moisture, high or low temperatures, contaminants or other causes.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

2.2 JOINT VOID-FORMER

A. Plastic, with a water stop.

B. ¼ depth of concrete slab thickness.

2.3 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Crafco Inc., an ERGON company; RoadSaver Silicone.
      b. Dow Corning Corporation; 888.
      c. Pecora Corporation; 301 NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Crafco Inc., an ERGON company; RoadSaver Silicone SL.
      b. Dow Corning Corporation; 890-SL.
      c. Pecora Corporation; 300 SL.

C. Single-Component, Self-Leveling, Polyurethane Joint Sealant for Concrete: ASTM D 5893, Type SL.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Sikaflex – 1C SL - Polyurethane SL.

D. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Pecora Corporation; Urexpan NR-200.

2.4 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant for Concrete: ASTM D 3406.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Crafco Inc., an ERGON company; Superseal 444/777.

B. Hot-Applied, Single-Component Joint Sealant for Concrete and Asphalt: ASTM D 6690, Types I, II, and III.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Meadows, W. R., Inc.; Sealtight 3405.
      b. Right Pointe; D-3405 Hot Applied Sealant.

2.5 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.6 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Immediately after sawcutting control joints, wash freshly sawed joints with a high pressure wash to remove saw slurry from the joint faces.

C. Immediately prior to installing joint sealant, remove oil, grease, wax, form-release agents, curing compounds, bitumens, laitance and old chalking material by sandblast, as recommended by manufacturer of sealant. Maximum sand blast angle, 25 degrees plus or minus 5 degrees. Complete two full passes for each joint to be sealed, one blast for each face.

D. Clean and dry with air blast. Do not contaminate air blast with oils or lubricants.

E. Remove frost and moisture in concrete joint substrates before commencing sealing.

F. Install bond breaker tape where needed or required by manufacturer’s recommendations to ensure that elastomeric sealants will perform properly.

G. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Depths: Saw cut joints if necessary to provide the required sealant thicknesses and depth. Install sealant to the depths indicated or, if not indicated, as recommended by the sealant manufacturer, but within the following general limitations measured at center (thin) section of bead:
   1. For sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75 percent of joint width, but not more than 5/8 inch deep nor less than 3/8 inch deep.
   2. For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than ½ inch deep nor less than ¼ inch deep.
   3. For joints sealed with non-elastomeric sealants and caulking compounds, fill joints full depth.

D. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of joint-sealant backings.
   2. Do not stretch, twist, puncture, or tear joint-sealant backings.
   3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place joint sealants so they directly contact and fully wet joint substrates.
   2. Install joint sealants in uniform, continuous ribbons without gaps or air pockets, with complete bonding of joint surfaces on opposite sides.
   3. Completely fill recesses in each joint configuration, unless otherwise indicated.
   4. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
   5. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove so that joint will not trap moisture and dirt.

F. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
   1. Remove excess joint sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

G. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

H. Spillage: Do not allow poured sealant compound to overflow or spill onto adjoining surfaces or to migrate into voids of adjoining surfaces. Clean adjoining surfaces to eliminate evidence of spillage.

I. Heating: Do not use overheated hot-applied sealants.

J. Edges: Unless indicated otherwise, recess exposed edges of gasket and exposed joint filler slightly behind adjoining surfaces so compressed units will not protrude from joints.

3.4 CURING AND CLEANING

A. Cure joint sealant compounds per manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength, and surface durability.

B. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.6 PAVEMENT-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within cement concrete pavement.
   1. Joint Location:
      a. Expansion and isolation joints in cast-in-place concrete pavement.
      b. Contraction joints in cast-in-place concrete slabs.
      c. Other joints as indicated.
   2. Silicone Joint Sealant for Concrete: Single component, nonsag or Single component, self-leveling.
   3. Urethane Joint Sealant for Concrete: Multicomponent, pourable, traffic-grade.
   4. Hot-Applied Joint Sealant for Concrete: Single component.
   5. Joint-Sealant Color: Color shall match the color of adjacent concrete surfaces

B. Joint-Sealant Application: Joints between cement concrete and asphalt pavement.
   1. Joint Location:
      a. Joints between concrete and asphalt pavement.
      b. Joints between concrete curbs and asphalt pavement.
      c. Other joints as indicated.
   2. Hot-Applied Joint Sealant for Concrete and Asphalt: Single component.

END OF SECTION

SECTION 32 16 00
DRIVEWAYS, SIDEWALKS, CURBS, GUTTERS, AND OTHER CONCRETE FLATWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes exterior cement concrete flatwork such as but not limited to the following:
   1. Driveways.
   2. Curbs ,gutters and waterways
   3. Sidewalks and Walkways.
   4. Other exterior site concrete flatwork

B. Related Sections include the following:
   1. Division 2 Section 31 23 00 – Earthwork for subgrade preparation, grading, and base course.
   2. Division 2 Section 32 13 73 – Pavement Joint Sealants for joint sealants of joints in concrete flatwork and at isolation joints of concrete flatwork with adjacent construction.
   3. Division 3 Section 03 30 00 – Cast-in-Place Concrete for general building applications of concrete.

1.3 REFERENCES

AASHTO M 6	Standard Specification for Fine Aggregate for Portland Cement Concrete
AASHTO M 154	Standard Specification for Air-Entraining Admixtures for Concrete
AASHTO M 80	Standard Specification for Coarse Aggregate for Portland cement Concrete
AASHTO M 182	Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats
ACI 117	Standard Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete for Buildings; American Concrete Institute International; 1996.
ACI 305 R	Hot Weather Concreting; American Concrete Institute International; 1991.

ACI 306 R	Cold Weather Concreting; American Concrete Institute International; 1988.
ACI CP-1(08)	Technical Workbook for ACI Certification of Concrete Field Testing Technician-Grade
ASTM A 307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
ASTM A 615/A 615M	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 1996a.
ASTM C 31/C31 M	Standard Practice for Making and Curing Concrete Test Specimens in the Field.
ASTM C 33	Standard Specification for Concrete Aggregates; 1993.
ASTM C 39/C39 M	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 1996.
ASTM C 94/C94M	Standard Specification for Ready-Mixed Concrete; 1996.
ASTM C 143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C 150	Standard Specification for Portland Cement; 1996.
ASTM C 171	Standard Specification for Sheet Materials for Curing Concrete; 1997.
ASTM C 172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method; 1994a.
ASTM C 260	Standard Specification for Air-Entraining Admixtures for Concrete; 1995.
ASTM C 494	Standard Specification for Chemical Admixtures for Concrete.
ASTM C 618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete; 1996a.
ASTM C 881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 1990.
ASTM C 1017/C 1017M	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete

ASTM C 1059/C1059 M	Standard Specification for Latex Agents for Bonding Fresh To Hardened Concrete
ASTM C 1064	Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete.
ASTM C 1077	Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM D 1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types); 1983 (reapproved 1991).
ASTM D 1752	Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM E 329	Standard Specification for Agencies Engaged in Construction Inspection and/or Testing
FS TT-P-1952	Pavement Markings

1.4 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with fly ash.

1.5 SUBMITTALS

A. Design Mixtures: For each concrete flatwork mixture satisfying the requirements of this section and Section 03 30 00 Cast-in-place Concrete. Include alternate mixture designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments
   1. Mix designs will be approved based on results of trial batches or on past history of mix design successes from project(s) within the last year.
   2. Use the same components in the trial batches that are to be used in the project. The Contractor assumes responsibility for the compatibility of all admixtures with the mix design and their potential effects on concrete properties.
   3. Personnel performing and witnessing trial batches, and performing compressive and flexural strength testing, must be performed by an AASHTO accredited laboratory paid for by Contractor.
   4. The Owner or Engineer may witness trial batch preparation and testing.

B. Product Data: For each type of manufactured material and product indicated.

C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
2. For any proposed mix design, provide test results for potential reactivity of coarse and fine aggregates in accordance with the requirements of this section.
3. When using potentially reactive aggregates in a mix design, provide results from appropriate testing to determine the ability of the combinations of cementitious materials and aggregates to control the reactivity

D. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

E. Joint Layout Plan: Submit plan showing location and type of each joint to be placed in the concrete flatwork.

F. Proof of finishers' ACI Certifications

G. Manufactures recommended installation procedures for joint sealing material which, when accepted by Engineer, will become the basis for accepting or rejecting the actual installation procedures used in the Work.

H. Delivery tickets per Section 03 30 00 – Cast-in-place Concrete

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1(08) or an equivalent certification program.

C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

D. Concrete Testing Service: All concrete testing will be done by a testing laboratory of the Owner's choice at the Owner's expense.

E. Do not change concrete Supplier until Engineer accepts new source and new mix design.

F. Remove product found defective after installation and install acceptable product at no additional cost to Owner.

G. Foreman of paving crew shall have completed at least three (3) projects of similar size and nature.

1.7 ACCEPTANCE

A. General: Acceptance is by lot. Lot size is specified below for each component.

B. Concrete Mix:
1. Lot size is 50 cu. yd. or fraction thereof of each concrete mix placed each day.
2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
5. For slump, air and temperature reject non-complying batches until 2 consecutive batches are compliant then continue in random batch testing for acceptance.

C. Strength
1. Lot size is 50 cu. yd. or fraction thereof of each concrete mix placed each day.
   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of five standard cylinder specimens for each composite sample.
3. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.
4. Strength of each lot will be satisfactory if the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
5. Remaining cylinders shall be held to verify test results, if required.

D. Installation:
1. Grades, finishes, cross-slopes and dimensions of completed pavement shall be checked for compliance with plan requirements. Standing water in curb and gutter or “bird baths” in flatwork are not permitted and shall be immediately corrected by removal of failed areas and replacement per these specifications and directions of the Engineer at no additional cost to the owner.

E. Test Results: Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design

compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

G. Additional Tests: Engineer may direct testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met.

H. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

I. Additional testing and inspecting, at Contractor's expense will be performed to determine compliance of replaced or additional work with specified requirements.

1.8 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Weather: Concrete placement shall conform to the requirements of ACI 305 R and ACI 306 R for hot and cold weather, respectively in addition to the requirements of Section 03 30 00 – Cast-in-place Concrete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
   2. Products: Subject to compliance with requirements, provide one of the products specified.
   3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
   1. Use flexible or curved forms for curves with a radius 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed, epoxy coated

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:
   1. Portland Cement: ASTM C 150, Type II.
   2. Do not use cement that contains lumps or is partially set.
   3. Do not mix cements originating from different sources.
   4. Do not use air-entrained cement.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar concrete flatwork applications and service conditions using similar aggregates and cementitious materials.
   1. Maximum Coarse-Aggregate Size: 3/4 inch nominal
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Mixing Water:
   1. For standard Type II Cement: ASTM C 94/C 94M

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
   1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   2. Retarding Admixture: ASTM C 494/C 494M, Type B.
   3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz. /sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete. Evaporation Retarder shall not be used as a finishing aid.

2.6 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.
   1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:
   1. Compressive Strength (28 Days): 4000 psi.
   2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.44.
   3. Do not exceed water/cementitious ratio.
   4. Calculate the water/cementitious ratio (w/c) according to the following formula:
      a. W = Water
      b. C Cement + Pozzolan
   5. Concrete Slump Limits:
      a. For concrete not containing water reducers, 4 inches, plus or minus 1 inch.
      b. For concrete containing low range water reducers: 1 inch to 5 inches for all classes of concrete.
      c. For concrete containing high range water reducers: 4 inches to 9 inches for all classes of concrete.
   6. Cement Content: 6.5 bags

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete having an air content as follows:
   1. Air Content: 6 percent plus or minus 1.0 percent for 3/4-inch nominal maximum aggregate size at point of placement.
   2. The range listed represents air content at point of placement. Make necessary adjustments for impacts to air content due method of placement.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals:

2.8 POZZOLAN

A. Fly Ash:

1. Fly ash must conform to ASTM C 618 Class F specifications with the following modifications:
    a. Loss on Ignition (LOI): not to exceed 3 percent.
    b. Maximum allowable CaO content: not to exceed 15 percent.
    c. Label the storage silo for fly ash to distinguish it from cement.
    d. Use different size unloading hoses and fittings for cement and fly ash.
    e. When used as partial portland cement replacement, the fly ash may replace 20% of the cement by weight.
2. Fly ash may be sampled and tested for compliance at any time.

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.
    1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. When automatic machine placement is used for placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce sidewalks, curbs, curbs and gutters, and other flatwork to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.
    1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

3.2 EXAMINATION

A. Examine exposed subgrades and base surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proceed with concrete flatwork operations only after nonconforming conditions have been corrected and subgrade and base is ready to receive flatwork.

3.3 PREPARATION

A. Assure the subgrade or base for the concrete has a firm even surface and is compacted meeting the requirements of Section 31 23 00 – Earthwork.

B. Remove loose material from compacted base surface immediately before placing concrete.

C. Remove sand, leaves, trash, rubbish, topsoil, and other objectionable materials prior to placing concrete.

D. Coat the surface of street fixtures with oil to prevent bond with concrete flatwork.

E. Notify Engineer a minimum of 48 hours prior to commencing laying operations.

3.4 LAYOUT

A. Curb, Gutter, Curb and Gutter, Waterways: Set lines, forms, screeds, etc to meet the following requirements:
   1. Line: Less than ½ inch variance in 10 feet and not more than 1 inch from true line at any location.
   2. Grade: Not more than ¼ inch variance in 10 feet. Flood curb and gutter and waterway with water after final cure has been reached. Remove and replace any area where ponding is found.

B. Sidewalk and Walkways: Set forms, screeds, etc to meet the following requirements:
   1. Cross-slope shall not be less than 1.5% nor more than 2%.
   2. Landings and doorway aprons shall not slope more than 2% in any direction.

C. Layout shall meet the requirements as given in the construction plans.

3.5 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for flatwork to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Check formwork for grade and alignment variance from the following tolerances:
   1. Top of forms shall not be more than ¼ inch from design grade
   2. Vertical face on longitudinal axis shall not be more than ¼-inch from true line.

C. Place joint filler in vertical position, in straight lines and secure to formwork during concrete placement.

D. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, grade lines, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work. Inspect formwork for line and grade and make corrections as required.

B. Remove snow, ice, or frost from base surface before placing concrete. Do not place concrete on frozen surfaces.

C. Obtain Engineer's review of base, forms, lines, etc. before placing concrete. Engineer's review does not relieve the Contractor's responsibility to ensure all Work is in compliance with the contract documents and these requirements and correct defective Work as required.

D. At the beginning of concrete placement, test slump, temperature and air entrainment. If corrections are necessary, placement may proceed after 2 subsequent and consecutive batches pass testing.

E. Moisten base to provide a uniform dampened condition, without standing water, at time concrete is placed.

F. Do not place concrete around manholes or other structures until they are at required finish elevation, cross-slope and alignment.

G. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

H. Do not add water to concrete during delivery to the Project site.

I. Water may not be added to the delivery truck at the project site prior to discharge unless approved by the Engineer. If water is added at the project site, record quantity of water added on delivery ticket.

J. Site-added air-entrainment. (Meet AASHTO M 154)
   1. Limit the use of site-added air-entraining agents to one addition (regardless of quantity) per load
   2. Use pre-measured admixtures.
   3. Record amount used on batch ticket.
   4. Rotate the drum at least 30 revolutions at the mixing speed recommended by the manufacturer.

K. Do not add water to fresh concrete after testing.

L. Deposit and spread concrete in a continuous operation. Prevent segregation of concrete mix. If placement operations are interrupted for more than 30 minutes, place a construction joint.

M. Place concrete so time between end of placement and beginning of finishing is less than 15 minutes.

N. Consolidate concrete with vibrator or other acceptable method. Do not use mechanical vibrators. Prevent dislocation of inserts.

O. Cold-Weather Placement: Comply with ACI 306.R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
   2. Do not use frozen materials or materials containing ice or snow.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.

P. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 JOINTS

A. General:
1. Review joint layout plan with Engineer.

B. Isolation/Expansion Joints:
1. Geometrics: ½ inch wide full depth filler that is flush with concrete surface. Do not place seal over top of filler.
2. Sidewalks, Walkways, Sidewalk Ramps:
   a. Place isolation joints to separate sidewalk from utility poles, hydrants, manhole frames, buildings, abutting sidewalks and other street fixtures or structures.
   b. Place isolation joints between the sidewalk and the back of curb returns and between the sidewalk and sidewalk ramps.
   c. Do not place isolation joints in sidewalk ramp surfaces.
3. Curb, Gutter, Curb and Gutter, Waterway:
   a. Do not place longitudinal joints in gutter flow-lines.
   b. Where gutter transitions extend beyond the curb return, place expansion joints at the ends of the gutters transition.
   c. Place isolation joints at beginning of curb radius and end of curb radius.
4. Slip Form Work: Expansion joints are not required except at beginning of curb radius, end of curb radius, structures, street fixtures, inserts, foundations and other structures.
5. Driveway approach: Do not place isolation joints in curb returns.

C. Contraction Joints: Contraction joints (crack control joints) are scorelines made to force crack joint location in concrete. Form weakened-plane contraction joints, sectioning concrete into areas as indicated.
1. Geometrics:
   a. Tooled Joints (score lines)
   b. Construct contraction joints to a depth equal to at least one-fourth ($1/4^{th}$) of the concrete thickness
   c. Top radius of joints shall be ½ inch.
   d. Saw Cut Joints: Saw joints before uncontrolled shrinkage cracking occurs. Do not tear or ravel concrete during sawing.
   e. Template Joints: 1/8 to 3/16 inch wide, ¼ depth of concrete.
2. Sidewalks.
   a. Place contraction joints at intervals equal to the width of the sidewalk and transverse to the direction of travel.
   b. Place radial contraction joints curves and curb returns.

c. Place longitudinal contraction joints in walks when width of walk in feet is greater the 2 times the walk thickness in inches. (e.g. maximum width of a 4 inch thick walk before placement of a longitudinal contraction joint is 8 feet.) Make longitudinal joints parallel to, or concentric with, the lines of the walk.

d. In walk returns make one joint radially midway between the beginning of curb return and end of curb return. Match the longitudinal and transverse joints with adjacent walks.

3. Curb, Gutter, Curb and Gutter, Waterway.
   a. Place joints at intervals not exceeding 12 feet.
   b. At curb radius and walk return make the joints radial.
   c. Where integral curb and gutter is adjacent to concrete pavement, align the joints with the pavement joints, where practical.

4. Other Flatwork:
   a. Joint Spacing, in feet, shall be twice the slab thickness measured in inches, unless otherwise indicated. (i.e. Slab thickness is 6-inches, joint spacing shall be 12-feet.) Joint spacing shall not exceed 15 feet.
   b. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
   c. Keep a minimum of three (3) working power saws on site when concrete operations are underway.
   d. Longitudinal joint spacing shall match the transverse joint spacing.
   e. Transverse joints shall extend across the width of the pavement and meet the joints of the adjoining concrete surfaces (i.e. sidewalk, curb and gutter, etc.).

D. Volunteer Crack Joints: If a volunteer crack joint occurs within any flatwork of this section, sawcut and remove cracked section at nearest contraction joints and replace the section at no additional cost to the owner.

3.8 FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/2-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

C. Apply broom finish longitudinal to curb, gutter, curb and gutter, and waterway flowline.

D. Apply broom finish transverse to sidewalk, walkway and other flatwork centerline as follows:
   1. Fine hair finish where grades are less than 6 percent.
   2. Rough hair finish where grades exceed 6 percent.

E. Remove form marks, tool marks, and other irregularities from finish surfaces.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306 R for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
   1. Curing Compound: Use a Type ID, Class A (clear with fugitive dye) membrane forming compound. Apply total coverage in 2 directions after texturing. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
   2. Eliminate thermal shock of concrete by keeping cure temperatures even throughout extent and depth on concrete slab.

3.10 REPAIRS AND PROTECTION

A. Protect concrete in compliance with requirements of Section 03 30 00 – Cast in Place Concrete. Remove and replace concrete flatwork that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Protect concrete from damage. Do not allow steel wheel rollers or steel wheel vehicles on the concrete flatwork.

C. Exclude traffic from concrete flatwork for at least 14 days after placement or until 100 percent of the design strength has been achieved as demonstrated by concrete cylinder compression tests.

D. If construction traffic is permitted, maintain concrete flatwork as clean as possible by removing surface stains and spillage of materials as they occur.

E. Protect fresh concrete from vandals, damage, pedestrian traffic, etc. Repair damaged section immediately to the satisfaction of the Engineer.

F. Remove saw-cut dust immediately. Do not allow saw-cut dust to be flushed down storm drains or into adjacent wetlands or landscaping areas.

G. Maintain concrete flatwork free of stains, discoloration, dirt, and other foreign material. Sweep concrete flatwork not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 32 31 11
AUTOMATIC GATE EQUIPMENT

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide all automatic gate operator systems with controls and appurtenant Work, complete and operable, in accordance with the Contract Documents.

1.2 SECTION INCLUDES

A. Electric gate operators.
   1. DoorKing Model 9150, or equal.

B. Parking gates and operators.

C. Sensors and controls.

1.3 RELATED SECTIONS

A. Section 32 31 13 – Field Fencing and Gates: Adjoining fences and gates.

B. Section 32 31 14 – Cantilever Slide Gates

C. Section 03 30 00 – Cast-in-Place Concrete: Concrete mounting pads.

D. Division 26 – Requirements for electrical connections.

1.4 REFERENCES

A. Underwriters Laboratories (UL): UL 325 – Standard for Safety for Door, Drapery, Gate, Louver, and Window Operators and Systems.

B. Canadian Standards Association (CSA): CSA C22.2 No. 247.

C. Underwriters Laboratories (UL): UL 991 – Standard for Tests for Safety Related Controls Employing Solid-State Devices.

D. American Society Testing Materials (ASTM): ASTM F2200 – Standard Specification for Automated Vehicular Gate Construction.

E. National Electrical Manufacturers Association (NEMA): NEMA ICS 6 – Industrial Control Systems: Enclosures.

1.5 SUBMITTALS

A. Submit under provisions of Section 01 33 20 – Submittal Procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.

2. Storage and handling requirements.
3. Installation methods.

C. Shop Drawings: Submit shop drawings showing layout, profiles, and product components, including anchorage, edge connections, and accessories.
1. Operation, installation, and maintenance manuals including wire diagrams.
2. Risers, layouts, and special wiring diagrams showing any changes to standard drawings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials and products in strict compliance with manufacturer's instructions and industry standards.

B. Store products indoors in manufacturer's original containers and packaging with labels clearly identifying product name and manufacturer. Protect from damage.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Substantial transformation and final assembly shall occur in the United States of America per Section 1605 of the ARRA-09.

B. Installer Qualifications: Installation performed by factory authorized dealer contractor specifically trained in gate operator systems of the type found within this section.
1. Provide documentation of maintenance and repair service availability for emergency conditions.
2. Provide quarterly maintenance for one year following Substantial Completion of the Project.

1.8 WARRANTY

A. Manufacturer's standard five (5) year warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: DoorKing, Inc. (Model 9150); 120 S. Glasgow Ave; Inglewood, CA 90301; Toll-Free Tel: 800-826-7493; Tel: 310-645-0023; Fax: 310-641-1586; Email: ghendrix@doorking.com; Web: doorking.com.

B. Substitutions: Or equal.

C. Requests for substitutions will be considered in accordance with provisions of Section 01 25 10 – Products, Materials, and Equipment.

2.2 SLIDING GATE OPERATORS

A. Microprocessor based solid-state control board interacting with card readers, RF transmitters, access control systems, ticket machines, other activating devices as

required, external devices (photo-eyes, contact edges) for entrapment protection and vehicle (loop) sensing systems. Control board shall include built-in close timer (1-25 seconds), built-in ports for two (2) plug-in loop detectors per gate opening, partial open input, programming switches to set various operating modes, inherent magnetic pulse obstruction sensing reverse system. System shall employ Fail-Safe operation upon primary (AC) power outage.

1. Compliance: Compliant to UL 325, UL 991 and CSA C22.2 No. 247 and listed by Intertek Testing Laboratories NA, Inc. (ETL), a Nationally Recognized Testing Laboratory.
    a. This model is intended for use in Class I, II, III and IV vehicular slide gate applications.
2. Warranty: Five (5) year manufacturer's standard warranty.
3. Maximum Gate Length:
    a. 45-feet with 1 HP motor.
4. Maximum Gate Weight:
    a. 1500 Lbs. with 1 HP motor.
5. Operator speed: approximately 11-inches per second.
6. Enclosure: 12 gage, 0.108 inch (2.6 mm) G90 hot-dipped galvanized steel, finished with polyester powdercoat, exterior grade semi-gloss texture gray.
7. Configuration: Left or right hand mount; front, center or rear mounting configurations.
8. Mounting: Pad or post mount.
9. Electrical Power Requirements: 115VAC..
10. Motor: Continuous Duty Motor.
    a. 1 HP
11. Dead Bolt Lock: Solenoid dead bolt engages if an attempt is made to force the gate open.
12. Fail-Safe Operation: Upon loss of primary (AC) power, system shall automatically be transferred to a fail-safe mode allowing the gate to be pushed open without the use of special knowledge, keys or other releasing mechanisms.
13. Primary Reduction: Adjustable clutch, single cog belt drive train.
14. Pulling Medium: #40 roller chain
15. Magnetic Limit Switches: Automatic setting with no mechanical switches to set, wear out or break.
16. Operating Switches: Built-in power (on-off), reset and operating switches.
17. Convenience Outlets: Two (2) 115 VAC for accessory transformers.
18. Entry Gate Keypad DoorKing Model 1506 (or approved equal)
    a. Stand-alone keypad programmable at the device.
    b. Code(s) programmed for gate entry at instruction/troubleshooting.
    c. Installed on gooseneck mounting post with a minimum access height of 5-ft.
19. Entrapment Protection
    a. Photo-electric eye (non-contact sensor).

b. Sensing edge (contact sensor).

20. Accessories: Provide the accessories listed below.
    a. Thermostatically controlled heater kit.
    b. Base Plate – for post mount applications.
    c. Chain tray kit – to support roller chain on long gates.
    d. Plug-in loop detectors.
    e. Electric reversing edge – reverses direction of gate on contact with an obstruction.
    f. Photo-electric beams – reverses direction of gate if the light beam is obstructed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. It is preferred, but not required, that this product be installed by a qualified technician who is certified by the Institute of Door Dealer Education and Accreditation (IDEA) as a Certified Automatic Gate Operator Installer (CAGOI).
B. DoorKing Model 9150 (or equal) shall be mounted, firmly secured, plumb and level, as required.
C. Wiring shall be uniform and in accordance with national electric codes and manufacturer's instructions.
D. All splices shall be in easily accessible junction boxes or on terminal boards.
E. All cable runs in all junction boxes shall be tagged and identified.
F. Coordinate all work with other effected trades and contractors.

3.2 SYSTEM INITIALIZING AND PROGRAMMING

A. System shall be turned on and adjustment made to meet requirements of specifications and on-site conditions.
B. System shall function as specified.

3.3 SYSTEM TEST PROCEDURES

A. System shall be completely tested to assure that all components and accessories are hooked-up and in working order.
B. System shall be pre-tested by contractor and certified to function in accordance with plans and specifications.
C. System shall be tested in presence of owner's representative.

3.4 OWNER INSTRUCTIONS

A. Installation contractor shall conduct up to (1) hour of instruction in use and operation of the system to designated owner representatives, within (30) days of acceptance.
B. Installation contractor shall conduct up to (1) hour of technical training, in troubleshooting and service of the system, to designated owner representatives within (90) days of system acceptance.

3.5 MANUALS AND DRAWINGS

A. Contractor shall provide owner with (2) copies of standard factory prepared operation, installation, and maintenance manuals. Manuals shall include typical wiring diagrams.
B. Contractor shall provide owner with (2) copies of any risers, layouts, and special wiring diagrams showing any changes to standard drawings, if required on project.

3.6 MAINTENANCE

A. The manufacturer recommends periodic maintenance at three-month intervals as described in the installation and maintenance manual.
B. External reversing devices should be checked at least once a month.

END OF SECTION

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SECTION 32 31 13
FIELD FENCING AND GATES

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide field fencing, double strand barb wire, swing gates and appurtenant Work, complete and operable, in accordance with the Contract Documents.

B. Single Manufacturer: Fencing, swing gates, accessories, fittings, and fastenings shall be products of a single manufacturer.

1.2 RELATED SECTIONS

A. Section 32 31 14 – Cantilever Slide Gates and Operators.

B. Section 32 31 11 - Automatic Gate Equipment.

C. Section 03 30 00 – Cast-in-Place Concrete

1.3 REFERENCE STANDARDS

ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

AASHTO M 181 Chain-link Fence

AASHTO M 232 Zinc Coating (Hot-Dip) on Iron and Steel Hardware

AASHTO M 279 Metallic-Coated, Steel Woven Wire Fence Fabric

AASHTO M 280 Metallic-Coated (Carbon) Steel Barbed Wire

American Wood-Preservers' Association (AWPA) Book of Standards

1.4 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures.

B. The Contractor, at a minimum, shall submit the following information for Engineer approval prior to installing any field fencing:
   1. Manufacturer's technical data, product specifications, standard details, certified product test results, installation instructions and general recommendations.

2. Scale layout of fencing, pedestrian gates, and accessories. Drawings shall show fence height, post layout, including sizes and sections; post setting and bracing configuration, details of gates and corner construction, and other accessories which may be necessary.

C. Samples: Samples of proposed fence components, at least 12 inches long, to illustrate the selected color and finish.

PART 2 - PRODUCTS

2.1 GENERAL

A. Dimensions indicated herein for all posts are outside dimensions, excluding coatings.

B. Fence fabric height shall be 5'-8" feet unless otherwise indicated.

2.2 WIRE MESH

A. Fence wire mesh shall be Grade 60, nominal 0.099 inch farm grade wire mesh fencing with 6-inch vertical wire spacing, refer to AASHTO M 279.

B. Mesh Finish: Mesh shall be Class I Zinc Coating

2.3 TREATED WOOD POSTS AND WOOD BRACE RAILS

A. All posts and rails shall be sound douglas-fir, hemlock, or pine that is free from decay, splits, multiple cracks, any other defect, and structurally suitable.

B. Round posts and braces
1. Round posts must have a minimum diameter of 5 inches.
2. Gate brace and corner posts must have a diameter of at least 5 inches.
3. No post or rail may deviate from a straight edge placed along its length by more than ½ the diameter of the post or rail.
4. Taper (diameter differential) in round members must not exceed 2 inches in 10 ft.
5. Fabricate posts and brace rails before pressure treating the wood members.
6. Apply field treatment preservations according to AWPA Standard M4 after field drilling or cutting. Refer to AWPA Standard M4, Section 7 for accepted field treatment preservative systems.
7. Keep round posts free of bark, protruding knots, and other irregularities.

C. Tension Wire: Tension wire shall be barbless 9 gauge Class 1 Zinc Coating. Refer to AASHTO M 181.

D. Fasteners:
1. Galvanized 9 gauge staples at least 1-1/2 inches in length.
2. Galvanized 9 gauge hog rings.
3. Galvanized rail end caps and set screws.

E. Barbed Wire: Barbed wire shall be two-strands of 0.099 inch diameter wire twisted with a four-point, nominal 0.080 inch barbs spaced no more than 5 inches apart. Refer to AASHTO M 280.

2.4 GATES

A. Fabrication: Perimeter frames of gates shall be fabricated from 1.875 inch outside diameter galvanized steel pipe with weight of 2.72 lb/ft. . Gate frames shall be assembled by welding. Welds shall be ground smooth. Horizontal and vertical members shall be provided to ensure proper gate operation and attachment of mesh.
   1. Provide one vertical support 1.675 inch galvanized steel tubing for gates over 7-ft wide placed in the center of the gate.
   2. Provide one adjustable truss rod of 3/8 inch minimum diameter per gate to prevent sagging on gates.
   3. Dimensions shown and specified are the minimum clear openings between gate posts. The supplier must provide a gate with fittings to fill the opening.
   4. Use wire mesh for gates.
   5. Supply hot-dipped galvanized steel fittings per AASHTO M 232.
   6. Double gates must have a center latch in place of a chain. Latch shall permit operation from either side of the gate, with a padlock eye as an integral part of the latch. A pin from the latch must fit in a socket embedded in concrete.
   7. Use 180 degree industrial hinges.
      a. Use hinges that will not twist, turn or allow sagging of the gate.
      b. Verify gates are capable of being opened and closed easily by on person.
      c. Pintles for gates on wood posts must be 5/8 inchs in diameter or larger.

2.5 RELATED ITEMS

A. Concrete: Concrete shall be provided according to Section 03 30 00 – Cast-In-Place Concrete.

2.6 MANUFACTURERS

A. Manufacturer's Qualifications: Field fencing and gates shall be products of a single manufacturer which has been successfully engaged in the production of such items for a period of at least 5 years.

B. Installer's Qualifications: Installation of the field fence shall be by the manufacturer or by a firm accepted and licensed by the manufacturer.

C. Manufacturers, or equal
   1. American Fence Company Inc.
   2. Mountain States Fence.
   3. United Fence Company

PART 3 - EXECUTION

3.1 INSPECTION

A. Prior to commencing installation, require Installer to inspect all areas and conditions within which Work of this Section will be performed. Dimensions and clearances shall be verified. Final grading shall be completed and all earth, brush, or other obstructions which interfere with the proper alignment and construction of fencing shall be removed.

3.2 INSTALLATION

A. General: Unless otherwise indicated, all posts shall be placed into the ground at the depths indicated on the drawings. Gate and related posts, corner posts, and other critical elements shall be provided with concrete foundations which are designed by an engineer to safely accommodate the loads to which they will be subjected. The soils report is appended to the Contract Documents and contains information regarding soil properties in the vicinity of the site.

B. Excavation: Holes for posts shall be drilled or hand excavated to the diameters and spacings indicated, in firm, undisturbed or compacted soil. Post foundations for the brace, corner, end, and gate posts which are not designed by an engineer shall comply with the following:

C. Holes shall be excavated to a diameter not less than 12 inches or not less than five times the largest dimension of the item being anchored, whichever is larger.

D. Depth for holes shall be not less than 51 inches; excavated approximately 3 inches lower than the post bottom, with bottom of posts set not less than 48 inches below finish grade surface, or as indicated in the Drawings.

E. Concrete shall completely encase the bottom of the post.

F. Setting Posts: Line posts shall be spaced at not more than 10-foot intervals, measured from center to center of the posts, parallel to the ground slope. Posts shall be set plumb and shall be centered in holes.
   1. Corner posts shall be installed where changes in the fence lines equal or exceed 15 degrees, measured horizontally.
   2. Each post shall be properly aligned vertically and its top aligned parallel to the ground slope. Posts shall be maintained in proper position during placement and finishing operations.

G. Concrete
   1. Concrete for footings may be placed without forms, providing the ground is firm enough to permit excavation to neat line dimensions. Prior to placing concrete, the earth around the hole shall be thoroughly moistened.
   2. Encasement concrete for footings shall be placed immediately after mixing in a manner such that there will be no concentration of the large aggregates. The concrete shall be consolidated by tamping or vibrating.
   3. Concrete footings shall have a neat appearance and shall be extended 2 inches above grade and troweled to a crown to shed water.

4. A minimum of 7 days shall elapse after placing the concrete footings before the fence fabric or barbed wire is fastened to the posts.

H. Bracing: Bracing shall be provided at all ends, corners, gates, and intermediate brace posts. Corner posts and intermediate brace posts shall be braced in both directions. Horizontal brace rails shall be set midway between the top rail and the ground, running from the corner, end, intermediate brace or gate post to the first line post. Diagonal tension members shall connect tautly between posts below horizontal braces.
1. Braces shall be so installed that posts remain plumb when diagonal rod is under proper tension.

I. Intermediate Brace Posts: Where straight runs of fencing exceed 500 feet, intermediate brace posts shall be installed, spaced equally between ends or corners; with additional posts provided as required, such that the spacing between intermediate brace posts does not exceed 500 feet. Intermediate brace posts shall be equivalent in size to corner posts and shall be braced with horizontal brace rails and diagonal tension members in both directions.

J. Fabric:
1. Wire mesh fabric shall be fastened on the secured side of the posts.
2. Fabric shall be stretched and securely fastened to posts.
3. Fabric shall be stretched and anchored in such a manner that it remains in tension after the pulling force is released.

K. Fasteners: Nuts for tension bands and hardware bolts shall be installed on the side of fence opposite the fabric side. Ends of bolts shall be peened or the threads scored to prevent removal of nuts.

L. Galvanized coating damaged during construction of the fencing shall be repaired by application of Galvo-Weld; Galvinox; or equal.

3.3 GROUNDING

A. Fences crossed by power lines of 600 volts or more shall be grounded at or near the point of crossing and at distances not exceeding 50 feet on each side of the crossing.

B. All fences, gates, and appurtenances enclosing electrical equipment areas, gas yards, or other hazardous areas shall be electrically continuous and grounded.

C. Ground conductor shall consist of No. 8 AWG solid copper wire. Grounding electrodes shall be ¾-inch by 10-foot long copper-clad steel rod. Electrodes shall be driven into the earth so that the top of the electrode is at least 6 inches below the grade.
1. Where driving is impracticable, electrodes shall be buried a minimum of 12 inches deep and radially from the fence. Top of electrode shall be not less than 2 feet or more than 8 feet from the fence

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using

tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 ADJUSTING

A. Gate: Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware, and other moving parts.

END OF SECTION

SECTION 32 31 14
CANTILEVER SLIDE GATES

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The contractor shall provide all labor, materials and appurtenances necessary for installation of the industrial ornamental cantilever gate system defined herein at the Fisher Ranch Water Treatment Plant.

1.2 RELATED WORK

A. Section 32 13 31 – Field Fencing and Gates

B. Section 03 30 00 – Cast in Place Concrete

C. Section 32 31 11 Automatic Gate Equipment.

1.3 SYSTEM DESCRIPTION

A. The manufacturer shall supply a total industrial ornamental cantilever gate system of the Ameristar® TransPort II® Classic™ design (or equal). The system shall include all components (i.e., tracks, uprights, bracing, pickets, hardware, fittings, and fasteners) required.

1.4 QUALITY ASSURANCE

A. The contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and materials and techniques specified.

1.5 REFERENCES

- ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- ASTM B117 - Practice for Operating Salt-Spray (Fog) Apparatus.
- ASTM B221 – Aluminum and Aluminum Alloy Extruded Bars, Shapes and Tubes
- ASTM D523 - Test Method for Specular Gloss.
- ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint.
- ASTM D822 - Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.
- ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
- ASTM D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.

- ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
- ASTM D3359 - Test Method for Measuring Adhesion by Tape Test.

1.6 SUBMITTAL

A. The manufacturer's submittal package shall be provided prior to installation.

1.7 PRODUCT HANDLING AND STORAGE

A. Upon receipt at the job site, all materials shall be checked to ensure that no damages occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism and theft.

PART 2 - MATERIALS

2.1 MANUFACTURER

A. All industrial ornamental cantilever gates shall conform to the Ameristar® TransPort II® gate system, Classic™ design, manufactured by Ameristar Perimeter Security USA Inc., in Tulsa, Oklahoma (or equal). The following additional information for each cantilever gate included in the project scope: 20-ft opening per leaf with a total opening of 40-ft (as shown in the Civil Drawings), and 7-ft height.

2.2 MATERIAL

A. The materials used for cantilever gate framing (uprights & diagonal bracing) shall be manufactured from ASTM B221 aluminum (designation 6063-T-6) with yield strength of 25,000 PSI, a tensile strength of 30,000 PSI and a standard mill finish. The TransPort™ enclosed tracks shall be manufactured from ASTM B221 aluminum (designation 6063-T-6) with a yield strength of 25,000 PSI, a tensile strength of 30,000 PSI and a standard mill finish.

B. Material for pickets shall be 1" square x 16 gauge steel. Picket on center spacing shall not exceed 5". Pickets shall be securely fastened to face of top and bottom enclosed track extrusions.

C. Material for gate uprights and diagonal bracing shall be 2” square x ¼” wall aluminum. The cross-sectional shape of the enclosed-track shall confirm to the manufacturers Fast-Trak™ design with as a single extrusion consisting of a 2” x 5” channeled support with integrated 2” x 2” enclosed-track raceway. Gates less than 24’ openings shall be constructed as a single track system, gates greater than 24’ openings shall be constructed as a dual track system.

D. Steel material for fence posts and pickets shall be galvanized prior to forming in accordance with the requirements of ASTM A653/A653M, with minimum yield strength of 45,000 psi

(310 MPa). The steel shall be hot-dip galvanized to meet the requirements of ASTM A653/A653M with a minimum zinc coating weight of 0.90 oz/ft2 (276 g/m2), Coating Designation G-90. Material for gate support posts shall be 4" square x 11 Ga. tubing.

E. Suspension Rollers for enclosed tracks shall be used at each support post to track connection. Each truck assembly shall be capable of being adjusted vertically via threaded rod for fine-tune adjustment. Truck assembly shall be constructed in a way so that the primary housing for the truck rollers shall pivot via ball-bearing connection to threaded rod.

2.3 FABRICATION

A. Gate frame uprights and diagonal bracing shall be pre-fabricated and pre-punched to accept frame fasteners. Enclosed track shall be pre-punched to accept gate uprights. Pickets shall be precut to specified length and predrilled to accept picket to track fasteners. Posts shall be precut to specified lengths.

B. Top and bottom enclosed track extrusions shall be mechanically fastened to vertical gate uprights and intermediate supports, as required by assembly instructions. Diagonal bracing shall be mechanically fastened to vertical gate uprights and intermediate supports, as required by assembly instructions. Pickets shall be mechanically fastened to top and bottom enclosed track, as required by assembly instructions.

C. The manufactured gate components shall be subjected to the Ameristar thermal stratification coating process (high-temperature, in-line, multi-stage, and multi-layer) including, as a minimum, a six-stage pretreatment/wash and an electrostatic spray application of a polyester finish. The topcoat shall be a "no-mar" TGIC polyester powder coat finish with a minimum thickness of 2 mils (0.0508mm). The color shall be black. The stratification-coated framework shall be capable of meeting the performance requirements for each quality characteristic shown in Table 1.

PART 3 - EXECUTION

3.1 PREPARATION

A. All new installation shall be laid out by the contractor in accordance with the construction plans.

3.2 GATE INSTALLATION

A. Cantilever support posts shall be set in concrete footers having a minimum depth of 48". The "Earthwork" and "Concrete" specification sections shall govern material requirements for the concrete footer. Posts setting by other methods such as plated posts or grouted core-drilled footers are permissible only if shown by engineering analysis to be sufficient in strength for the intended application.

B. Gate to be installed per manufacturers gate installation instructions. Gate shall be installed in compliance with ASTM F2200 standards.

3.3 GATE INSTALLATION MAINTENANCE

A. When cutting/drilling posts adhere to the following steps to seal the exposed steel surfaces;
   1. Remove all metal shavings from cut area.
   2. Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry.
   3. Apply 2 coats of custom finish paint matching fence color. Failure to seal exposed surfaces per steps 1-3 above will negate warranty. Ameristar spray cans or paint pens shall be used to prime and finish exposed surfaces; it is recommended that paint pens be used to prevent overspray. Use of non-Ameristar parts or components will negate the manufactures' warranty.

3.4 GATE INSTALLATION

A. Gate posts shall be spaced according to the manufacturers' drawings, dependent on clear opening. The manufacturers' gate drawings shall identify the necessary gate hardware required for the application. Gate hardware shall be provided by the manufacture of the gate and shall be installed per manufacturer's recommendations.

3.5 CLEANING

A. The contractor shall clean the jobsite of excess materials; post-hole excavations shall be scattered uniformly away from posts.

Table 1 – Coating Performance Requirements

Quality Characteristics	ASTM Test Method	Performance Requirements
Adhesion	D3359 – Method B	Adhesion (Retention of Coating) over 90% of test area (Tape and knife test).
Corrosion Resistance	B117, D714 & D1654	Corrosion Resistance over 1,000 hours (Scribed per D1654; failure mode is accumulation of 1/8" coating loss from scribe or medium #8 blisters).
Impact Resistance	D2794	Impact Resistance over 60 inch lb. (Forward impact using 0.625" ball).
Weathering Resistance	D822 D2244, D523 (60˚ Method)	Weathering Resistance over 1,000 hours (Failure mode is 60% loss of gloss or color variance of more than 3 delta-E color units).

DIVISION 33
UTILITIES

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SECTION 33 05 01
HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The Contractor shall provide high density polyethylene pipe and appurtenances, complete in place, in accordance with the Contract Documents.

1.2 RELATED SECTION

A. Section 31 23 00 – Earthwork

1.3 REFERENCES

A. The Materials and Work furnished shall be, as a minimum, in accordance with the latest editions of the following standards except as such Standard are modified and supplemented in this section.

AWWA C906	Standard for Polyethylene (PE) Pressure Pipe & Fittings, 4 inch (100 mm) through 63 inch (1,575 mm) for Water Distribution and Transmission
ASTM D1238	Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1248	Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D2837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM D3035	Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

ASTM D256	Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
ASTM D2683	Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM F1055	Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing
ASTM D2657	Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
ASTM F2164	Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
ASTM F1417	Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
PPI TR-33	Generic Butt Fusion Joining Procedure for Field Joining of PE Pipe

1.4 SUBMITTALS

A. The Contractor shall submit the following information and data. See Section 01 33 20 Submittal Procedures.
   1. Product Data: Provide data indicating pipe, pipe accessories and fittings.
   2. Manufacturer's Installation Instructions: Indicate special procedures required to install products specified.
   3. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
   4. Certified Resin Test Reports covering the physical, stress, regression, thermal and impact tests of resin material to be used for the pipe. Submit this information prior to manufacturing or fabricating any pipe.
   5. Proposed butt fusion procedures including training and qualification requirements and joint repair procedures shall be submitted to the Engineer for review and approval.
   6. Qualifications of Butt Fusion Welders and Welding Operators
      a. All butt fusion welders and welding operators shall be qualified and certified for all portions of the work specified in this section. Welder qualification requires that during the past 12 months all welders and welding operators have successfully completed certified butt-fusion joints using the pipe and welding machine proposed for this project.
      b. Current welder and welding operator performance qualification test records shall be submitted to the Engineer for review and approval prior to commencing field operations.
      c. Personnel that will be operating the butt fusion welder shall be certified by either 1 and 3, or 2 and 3 of the following criteria:

1) Previous demonstrated experience during the past 12 months, in the use of the procedure on similar projects using the same welding machines and type of pipe proposed.
2) Appropriate training and apprenticeship
3) All operators shall make a specimen joint from the pipe to be used on the project. This joint shall then be subjected to the test requirements specified herein.

7. Fusion parameters including the recommended limits of all criteria recorded by the data logger.
8. Fusion report for each joint, which shall include the following information.
   a. Pipe size and dimensions
   b. Machine size
   c. Operator identification
   d. Job identification number
   e. Weld number
   f. Fusion, heating and drag resistance settings
   g. Heater plate temperature
   h. Time Stamp
   i. Heating and curing time of weld
   j. Curing temperature readings and time stamps of readings
   k. Ambient air temperature and humidity
   l. Error message and warnings for out of range temperature or pressure settings.

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable codes for materials and installation of the Work in this Section.

1.6 PROJECT CONDITIONS

A. Coordinate the Work on water lines and connections to existing water lines with the Owner.

1.7 QUALITY CONTROL

A. Any pipe manufactured prior to review and approval of all required prefabrication submittals will be at the Contractor's own risk.

B. Review of the Contractor's shop drawings shall not relieve the Contractor of any responsibility for accuracy of dimensions and details, nor shall mutual Agreement of dimensions or details relieve the Contractor of responsibility for Agreement and conformity of its Shop Drawings with the Contract.

1.8 QUALITY ASSURANCE

A. Fabrication, processing, testing and inspection operations affecting the pipe and associated accessories shall, at any time, be subject to quality assurance surveillance by Owner, or Engineer. Such surveillance shall be at the discretion of the Owner. Such surveillance does not relieve the Contractor from responsibility for the Work.

B. All deviations from this specification section must be documented and referred to Engineer for resolution.

C. The Contractor shall submit to the Engineer an affidavit from the manufacturer that the pipe, specials, fittings, and other products of material furnished under this Contract comply with all applicable provisions of AWWA C906 standards and this specification.

D. DOCUMENTATION: The following items shall be documented and stored as part of the manufacturer's permanent records. Copies of all documentation shall be provided to the Engineer.

1. Documentation from the resin's manufacturer showing results of the following tests for resin identification:
    a. Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer, ASTM D1238
    b. Standard Test Method for Density of Plastics by the Density - Gradient Technique, ASTM D1505
2. The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specific polyethylene resin being utilized in the manufacture of this product. This stress regression testing shall have been done in accordance with ASTM D2837 and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1,600 psi as determined in accordance with ASTM D2837.
3. Production staff shall check each length of pipe produced for the items listed below. The results of all measurements shall be recorded on production sheets, which becomes part of the manufacturer's permanent records.
    a. Pipe in process shall be checked visually, inside and out for cosmetic defects (grooves, pits, hollows, etc.)
    b. Pipe outside diameter shall be measured using a suitable periphery tape to ensure conformance with ASTM D3035.
    c. Pipe wall thickness shall be measured at 12 equally spaced locations around the circumference at both ends of the pipe to ensure conformance with ASTM D3035.
    d. Pipe length shall be measured.
    e. Pipe marking shall be examined and checked for accuracy.
    f. Pipe ends shall be checked to ensure they are cut square and clean.
    g. Subject inside surface to a "reverse bend test" to ensure the pipe is free of oxidation (brittleness).
    h. Copies of all manufacturer documentation shall be submitted to the Engineer for review and approval upon completion of manufacturing.

E. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished as a part of the Work.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Contractor shall comply with the following minimum requirements:
   1. Referenced standards for all materials, processes, methods, tests, etc to be used in completion of the Work.
   2. Delivery of all pipe and materials, all aspects of which shall be conducted in such a manner as to minimize handling, provide proper weather protection and storage, and to meet schedule requirements.
   3. Furnish and use load rated nylon-type slings for securing, lifting, and unloading pipe sections; or, the use of acceptable protective wraps to minimize damage from the alternate rigging equipment.
   4. Internal timber bracing shall be provided to maintain pipe shape and integrity throughout plant storage, transportation, and site storage operations through installation and backfill placement. Internal bracing shall not be removed until a minimum of 2 feet of compacted trench zone material is placed above the top of the pipe.

2.2 MANUFACTURER

A. All HDPE pipe and HDPE fittings shall be from a single manufacturer, who is fully experienced, reputable and qualified in the manufacture of the HDPE pipe to be furnished. The pipe shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these Specifications. Qualified manufacturers shall be: PLEXCO Division of Chevron Phillips Chemical Company, DRISCOPIPE as manufactured by Chevron Phillips Co., Inc., WL Plastics or equal as approved by the Engineer.

2.3 PIPE IDENTIFICATION

A. The following shall be continuously indent printed on the pipe or spaced at intervals not exceeding 5-feet:
   1. Name and/or trademark of the pipe manufacturer.
   2. Nominal pipe size.
   3. Dimension ratio.
   4. The letters PE followed by the polyethylene grade in accordance with ASTM
   5. D1248 followed by the hydrostatic design basis of 1600 psi, e.g., PE 4710.
   6. Manufacturing standard reference, e.g., ASTM D-3035, as required.
   7. A production code from which the date and place of manufacture can be determined.
   8. Color Identification, either striped by co-extruding longitudinal identifiable color markings or shall be solid in color and as follows:
      a. BLUE – Potable Water
      b. GREEN – Sanitary Sewer
      c. LAVENDER – IQ cover all

B. Marking Tape: Marking tape shall be provided and installed as shown in Drawings and per Engineer approval.

2.4 COMPATIBILITY

A. Contractor is responsible for compatibility between pipe materials, fittings and appurtenances.

2.5 WARRANTY

A. The pipe Manufacturer shall provide a warranty against manufacturing defects of material and workmanship for a period of ten years after the final acceptance of the project by the Owner. The Manufacturer shall replace at no expense to the Owner any defective pipe/fitting material including labor within the warranty period.

2.6 MATERIALS

A. Materials used for the manufacture of polyethylene pipe and fittings shall be made from a PE 4710 high density polyethylene resin compound meeting a minimum cell classification 445574C per ASTM D3350 and ASTM F714.

B. High Density Polyethylene (HDPE) pipe shall be manufactured in accordance with AWWA C901-96 for sizes ½-inch through 3-inch diameters and to the requirements of ASTM D 3035. Pipe 4-inches and above shall be manufactured to the requirements of ASTM F714 and AWWA C906-99.

C. Unless otherwise noted, diameters shown in the Contract Documents shall refer to Iron Pipe Size (IPS) system conforming to the requirements of AWWA C906.

D. If rework compounds are required, only those generated in the Manufacturer's own plant from resin compounds of the same class and type from the same raw material supplier shall be used. Clean rework material of the same type grade, and cell classification generated from the manufacturers own pipe and fitting production may be used by the same manufacturer as long as the pipe, tubing and fittings produced meet all requirements of AWWA C906.

E. Dimensions and workmanship shall be as specified by ASTM F714. HDPE fittings and transitions shall meet ASTM D3261. HDPE pipe shall have a range of density 0.956-0.964 grams per cubic centimeter. All HDPE pipe and fittings shall have a Hydrostatic Design Basis (HDB) of 1,600 psi at 73.0°F in accordance with ASTM D2837.

F. The extruded pipe shall have impact strengths greater than 42 in-lb/in in accordance with ASTM D256 Method A, with a material thickness representative of the cross-section in which the material is to be used.

G. The pipe Manufacturer shall certify compliance with the above requirements.

2.7 FABRICATION

A. Pipe shall be homogenous throughout and uniform in color, opacity, density and other properties as prescribed in the Resin Manufacturers Specifications. The inside and outside surfaces shall be semi-matte to glossy in appearance and free from sticky or tacky material. The pipe walls shall be free from cuts, cracks, holes, blisters, voids, foreign inclusions, or other defects that are visible to the naked eye that may affect wall integrity.

B. Pipe dimensions and wall thickness variations shall be in conformance with requirements of AWWA C906.

C. Pipe shall be finished smooth throughout all inside surfaces and true to all specified tolerances circumference and diameter such that: The difference between maximum and minimum diameters, at any cross-section along the length of the pipe does not exceed 1% of the nominal diameter.

D. Special pipe sections, fittings, and special pieces shall be completely fabricated in the shop. All pipe fittings shall be fabricated or molded to correct dimensions throughout the entire length. Ends cuts shall be clean, squarely-made, and suitable for field welding, without drawn, ragged, gouged, or split ends.

E. All HDPE fittings, unless noted otherwise on the drawings shall be fabricated in conformance with the requirements of AWWA C906. Molded fittings shall meet the requirements of ASTM D3261 for butt-type fittings and this specification.

2.8 FITTINGS

A. All molded fittings and fabricated fittings shall be fully pressure rated to match the pipe SDR pressure rating to which they are made. All fittings shall be molded or fabricated by the manufacturer. No Contractor fabricated fittings shall be used unless approved by the Engineer.

B. Polyethylene fittings furnished under this specification shall be manufactured using compounds complying with the requirements of HDPE pipe above and all appropriate requirements of AWWA C906. Socket fittings shall comply with ASTM D2683, Butt Fusion fittings shall comply with ASTM D3261. Electrofusion fittings shall comply with ASTM F1055. Mechanical fittings (e.g. back-up rings, etc.) shall be of stainless steel, including stainless steel hardware, as indicated in the drawings and shall be approved only after submission of appropriate test data and service histories indicating their acceptability for intended service. In all cases, the specification and requirements for the fittings supplied shall comply with the appropriate sections of AWWA C906 and must be approved by the Engineer. NO size on size wet taps shall be permitted.

C. The manufacturer of the HDPE pipe shall supply all HDPE fittings and accessories as well as any adapters and/or specials required to perform the work as shown on the Drawings and specified herein.

2.9 SHIPPING, STORAGE & HANDLING

A. All materials shall be properly loaded so that they will not bear on each other, and shall be braced to prevent damage to material during shipping. Pipe shall be stacked on level ground and per the manufacturer's recommendations to prevent pipe from becoming out of round.

B. All loose parts shall be crated or boxed for shipping, appropriately identified and shipped with the associated pipe sections.

C. Contractor shall protect pipeline sections stored at the site from damage, including weather and vandalism.

D. Pipes shall be stored on level ground, preferably turf or sand, free of sharp objects, which could damage the pipe OR on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports. Stacking of the polyethylene pipe shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. The Contractor shall abide by the required handling techniques specified by the Supplier.

E. The handling of the pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects

F. All piping products shall be kept free from dirt, grease, all petroleum based products, and other foreign matter.

G. The Contractor shall provide suitable lifting equipment, slings, spreader bars, rigging etc needed to handle the pipe. In no case shall any equipment be used that is not rated to handle the intended loading or conditions of use to which it is subjected. The use of cables and chains is prohibited.

H. The Contractor shall be responsible for the pipe until such time as it is installed and accepted by the Engineer.

I. The Contractor shall remove any temporary attachments to special components for installation by the Supplier for transportation purposes.

2.10 BEDDING AND COVER MATERIALS

A. Pipe bedding Material: As specified in Section 31 23 00 – Earthwork and in Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION – HDPE PIPING

A. High Density Polyethylene (HDPE) Pipe shall be installed in accordance with the instructions of the manufacturer, as shown on the Drawings and as specified herein. A factory qualified joining technician as designated by the pipe manufacturer shall perform all heat fusion joints.

B. Under no circumstances shall the pipe or accessories be dropped into the trench or forced through a directional bore upon “pull-back”.

C. The maximum allowable depth of cuts, scratches or gouges on the exterior of the pipe is 5 percent of wall thickness. The interior pipe surface shall be free of cuts, gouges or scratches. Sections of pipe with cuts, scratches or gouges exceeding 5 percent of the pipe wall thickness shall be removed completely and the ends of the pipeline rejoined. Repair of damaged pipe during or after installation shall conform to the fabricator’s repair procedures or by an Engineer approved repair method.

D. When laying pipe is not in progress, the open ends of the pipe shall be closed by fabricated plugs, or by other approved means.

E. The interior of the pipe shall be cleaned of any foreign matter before being lowered in the trench and kept clean during placement, joint welding, bedding and backfilling operations by plugging or other approved method. Groundwater shall not be permitted to enter the pipe. The full length of each pipe section and each bend shall rest solidly on the compacted bedding material.

F. All HDPE pipe must be at the temperature of the surrounding soil at the time of backfilling and compaction.

G. If a defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Owner. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required.

H. Contractor shall install HDPE pipe when the ambient air temperature conforms to manufacturer's specifications. The Contractor will be responsible for verifying the temperature by maintaining a log listing dates, times, length of pipe installed and ambient temperature during installation.

I. Trench bottoms shall be graded such that each section of pipe shall be placed to the specified depth or elevation with uniform support. When the bottom of the trench has been excavated below the specified depth or elevation it shall be brought to the specified depth or elevation by backfilling with approved pipe zone material. When material at the bottom of the trench is determined to be unsuitable by the Engineer, it shall be removed and the trench backfilled with approved subgrade material or bedding material to the specified depth of excavation.

J. During pipe installation, the trench bottom shall be kept free of frost, frozen earth, or standing water. The Contractor shall maintain the trench in good, stable condition at all times to prevent caving.

K. Precautions shall be taken to prevent flotation of the pipe in the trench.

L. The pipeline may be buried as it is installed, provided all inspection, testing and backfill requirements are met.

M. All areas disturbed by installation of the pipeline shall be restored in accordance with the specification and drawings.

3.2 JOINING METHOD

A. HDPE pipe shall be joined with butt, heat fusion joints as outlined in ASTM D3261 and conform to the Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe, Technical Report TR-33, published by the Plastic Pipe Institute (PPI). All joints shall be made in strict compliance with the manufacturer's recommendations. A factory qualified joining technician as designated by pipe manufacturer or experienced, trained technician shall perform all heat fusion joints in the presence of the Inspector. The Contractor shall install the HDPE pipeline complete, including bends, couplings, valves, and other associated fittings and appurtenances as shown on the drawings or specified herein and make all necessary connections to the lines and grades shown on the Drawings and in accordance with these specifications.

B. The Contractor shall furnish all welding equipment and all construction materials and equipment required for lugs, railings, templates, spiders or other supports and internal bracing as may be required to hold the components firmly within the specified tolerances during welding, concrete placement or backfill placement. The contractor shall also furnish and install all necessary positioning devices, ties, pedestals and supports required for installation. Details of such equipment shall be included in the proposed installation procedure to be submitted to the engineer prior to the start of work.

C. Lengths of pipe shall be assembled into suitable installation lengths by the butt-fusion process. All pipes so joined shall be made from the same class and type of raw material made by the same raw material supplier. Pipe shall be furnished in standard laying lengths not to exceed 50 feet and no shorter than 20 feet. Installation shall be in accordance with the requirements of AWWA C906 unless otherwise noted, and the Manufacturer's instructions. Contractor shall be responsible for correct fitting of all pipeline members and components.

D. The polyethylene flange adapters shall be used at pipe material transitions and other locations as indicated in the drawings. The adapters shall be connected together or to other flanges by using a stainless steel "back-up" ring conforming to ANSI B16.1 and shaped as necessary to suit the outside dimensions of the pipe. Ensure that back up rings are in place prior to joining flange adapter to piping or other components. The flange adapter assemblies shall be connected with corrosion resistant bolts and nuts of Type 316 Stainless Steel as specified in ASTM A726 and ASTM A307. All bolts shall be tightened to the manufacturer's specified torques. Bolts shall be tightened alternatively and evenly. After installation apply a non-oxide grease coating to bolts and nuts.

E. Where indicated, sleeve couplings shall be used to make HDPE joints. When sleeve couplings are used, stainless steel (Type 316), pipe stiffeners shall be inserted inside of each HDPE pipe end as recommended by the manufacture to prevent the pipe from going out of round and to ensure a leak free joint. Sleeve couplings shall be specifically rated for service with HDPE pipe and shall be as specified in the Contract Documents. Sleeve coupling shall only be used where indicated in the plans and in conjunction with an HDPE Pipe Anchor Block.

3.3 PREPARATION

A. Butt-fusion welded joints: Refer to Manufacturers recommended procedures. All joints formed by butt fusion processes shall be completed in strict accordance with the Manufacturers specified procedures, except where specifically called out in the specifications or drawings. Minimum requirements for butt-fusion welded joints are as follows:

1. Pipe ends shall be made clean and square prior to fitting and alignment
2. Care shall be taken to assure a clean work area, free from airborne dust, moisture, or other foreign matter which may contaminate the finished weld.
3. All internal surfaces of the pipe shall be maintained clean following completion of a weld and prior to starting the next joint.
4. All butt-fusion joints shall be water tight under the maximum internal pressure.

3.4 BACKFILL PLACEMENT

A. Pipe zone material shall be placed in accordance with Section 31 23 00 Earthwork. Care shall be taken to ensure that the material is carefully worked and compacted into the area beneath

and around the pipe to provide continuous support to the pipe. Material shall be properly haunched to provide support. Care shall be taken to avoid movement of the pipe during placement and compaction of the bedding material. Pipe bedding shall be placed to the limits shown on the drawings.

B. Trench backfill shall be placed in accordance with Section 31 23 00 Earthwork.

C. No construction vehicles or ride-on mechanical compaction equipment shall be permitted to travel over the pipe until a minimum of 2 feet of trench backfill is placed above the top of the pipe.

3.5 CONNECTION TO EXISTING

A. Mechanical connections of the polyethylene pipe to auxiliary equipment such as valves, pumps and tanks shall be through flanged connections which shall consists of the following:
   1. A polyethylene flange adapter shall be thermally butt-fused to the stub end of the pipe.
   2. A Type 316 stainless steel back up ring shall mate with the polyethylene flange adapter.
   3. Type 316 stainless steel bolts and nuts shall be used to complete the connection.
   4. Flange connections shall be provided with a full-face neoprene gasket.

B. All transitions from HDPE pipe to ductile iron or PVC shall be made per the approval of Engineer and per the HDPE pipe manufacturer's recommendations and specifications. A molded flange connector adapter with a back-up ring assembly shall be used for pipe type transitions. Ductile iron back-up rings shall mate with cast iron flanges per ANSI B16.1. A type 316 stainless steel back-up ring shall mate with a type 316 stainless steel flange per ANSI B16.1 and shall be used in all buried applications.
   1. Transition from HDPE to ductile iron fittings and valves shall be approved by Engineer before installation.
   2. No solid sleeves couplings shall be allowed between such material transitions.
   3. The pipe supplier must certify compliance with the above requirements

C. Prior to making connections to any existing structure or pipe, ensure that new pipe has had the time required to acclimate to the buried conditions. Make the appropriate adjustments required by the thermal expansion and contraction properties of HDPE materials before connecting to any dissimilar material or structure.

3.6 FIELD QUALITY CONTROL

A. On days butt fusions are to be made, the first fusion shall be a trial fusion in the presence of the Inspector. The following shall apply:
   1. Heating plates shall be inspected for cuts and scrapes. The plate temperature shall be measured at various locations to ensure proper heating/melting per manufacturer's recommendations and as approved by the Inspector.
   2. The fusion or test section shall be cut out after cooling completely for inspection.
   3. The test section shall be 12" or 30 times (minimum) the wall thickness in length and 1" or 1.5 times the wall thickness in width (minimum).

4. The joint shall be visually inspected as to continuity of "beads" from the melted material, and for assurance of "cold joint" prevention (i.e. – joint shall have visible molded material between walls of (pipe). Joint spacing between the walls of the two ends shall be a minimum of 1/16" to a maximum 3/16".

3.7 TOLERANCES

A. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16-in per foot of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site. Laying instructions of the manufacturer shall be explicitly followed. Good alignment shall be preserved during installation. Deflection of the pipe shall occur only at those places on design drawings and as approved by the Engineer. Fittings, in addition to those shown on the Drawings, shall be used only if necessary or required by the Engineer.

3.8 CLEANING

A. Do not allow dirt, grease, mud, groundwater, tools, equipment and all other foreign matter to enter the pipe at any point during construction.

B. All pipes shall be completely flushed at a rate with water velocities no less than 4.0 feet per second for pipes up to 12 inches in diameter and 3.0 feet per second for all other pipes. For large diameter pipes, alternate methods, including pigging, of cleaning the pipe may be proposed by the Contractor, subject to the approval of the Engineer, provided proposed method will provide a clean pipe equivalent to flushing as determined by the Engineer.

C. No debris, rubbish, dirt, rocks, or other foreign material shall be permitted to enter downstream sections of the pipeline or system.

D. Furnish, install and permanently remove all cross-connections, piping, valving, ports, etc required to complete the cleaning process. Obtain approval of the Engineer prior to adding any components to the pipeline.

3.9 HYDROSTATIC PRESSURE TESTING

A. Hydrostatic pressure testing shall be conducted per the requirements of ASTM F 2164 and these specifications.

B. All HDPE mains shall be field-tested. Contractor shall supply all labor, equipment, material, gages, pumps, plugs, meters and incidentals required for testing. Each main shall be pressure tested upon completion of the pipe laying and backfilling operations, including placement of any required temporary roadway surfacing.

C. Submit a plan for testing, including schedule, method for water conveyance, control, and disposal, to the Engineer for review at least 10 days before starting the test and notify the Engineer a minimum of 48 hours prior to test

D. The maximum test pressure shall be as indicated in the Drawings but shall not exceed 150 percent of the maximum working pressure of the pipe or the design pressure of any component on the pipe, whichever is less..

E. The test temperature of the piping and the test liquid (water) shall not exceed 73 degrees F. or the temperature related to the pressure rating of the pipe as reported by the manufacturer.

F. Test equipment, preparations and procedures shall implicitly follow the requirements of ASTM F 2164 and the Manufacturer's recommendations.

G. In preparing for test, fill line slowly with water. Maintain flow velocity less than 2 feet per second or less than the capacity of any air release devices use to expel trapped air, whichever is less.

H. Expel air completely from the line during filling and again before applying test pressure. Air shall be expelled by means of taps at points of highest elevation. Any taps installed solely for the purpose of releasing trapped air shall be permanently capped at the conclusion of the test.

I. Once all air is expelled and all testing equipment and pipeline components are adequately braced, gradually increase the pressure in the pipeline to the required maximum test pressure. Hold test pressure for four hours adding make-up water as required to maintain the noted maximum test pressure.

J. After the four hour equalization period, reduce pressure in the pipeline by 10 psi to the test pressure and monitor the pressure for 1 hour. Do not increase the pressure or add make-up water during this time.

K. During and after the one-hour test period, observe all components, joints, fittings, and appurtenances of the pipeline for visible signs of leakage. Any visible signs of leakage indicate a failed test, all such leaks shall be repaired and pipeline retested before pipeline will be accepted. If any visible signs of leakage in any butt-fusion joints in the pipe are noted, immediately stop the test and carefully release the test pressure. Repair the noted leaks and restart test procedure from beginning.

L. A successful hydrostatic pressure test will be indicated by no visible signs of leakage and a steady pipeline pressure within 5 psi of the test pressure throughout the one hour test period without increasing the pressure or the addition of make-up water.

M. Upon completion of the test, the pressure shall be bled off from a location other than the point where the pressure is monitored. The pressure drop shall be witnessed by the Engineer at the point where the pressure is being monitored and shall show on the recorded pressure read-out submitted to the Engineer.

N. Repair and/or replace any failed pipeline sections, components, fittings, valves or other appurtenances to the satisfaction of the Engineer and at no additional expense to the Owner.

3.10 LOW PRESSURE AIR TESTING

A. HDPE pipelines intended for use as air ducts shall be tested for leakage prior to placing the pipe in service. Air test shall not be used for acceptance of any HDPE pipeline except those indicated herein or in the Drawings. Furnish, install and completely remove all fittings, branches, plugs, valves and other appurtenances required to complete the testing process.

B. Prior to beginning air test, HDPE pipeline shall be isolated from pipeline components not rated for the air pressures called for in the test.

C. Low pressure air testing shall be completed per the requirements of ASTM F1417 as given in Section 33 08 00 – Gravity Piping Testing and Inspection.

D. Pipeline shall be inspected for all visible infiltration leaks as evidenced by infiltrating groundwater. Leaks shall be located and repaired at no additional cost to the Owner and to the satisfaction of the Engineer.

3.11 MANDREL TESTING

A. After successful completion of hydrostatic test, mandrel test all buried HDPE piping.

B. Mandrel configuration: Rigid with circular cross-section with a diameter of not less than 95% of the average inside diameter of the pipeline with a length of circular proportion equal to the nominal diameter of the pipeline.

C. Mandrel pulling method shall be by hand, rope or as directed by the Engineer.

END OF SECTION

SECTION 33 05 07
POLYVINYL CHLORIDE (PVC) PIPE (AWWA C900 AND C905, MODIFIED)

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide polyvinyl chloride (PVC) pressure pipe, complete in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ANSI/AWWA C104/A21.5	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
ANSI/AWWA C105/A21.5	Polyethylene Encasement for Ductile Iron Pipe
ANSI/AWWA C110/A21.10	Ductile-Iron and Gray-Iron Fittings 3-in Through 48-in for Water and Other Liquids
ANSI/AWWA C111/A21.11	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
ANSI/AWWA C600	Installation of Ductile-Iron Water Mains and Appurtenances
ANSI/AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe 4-in Through 12-in for Water Distribution
ANSI/AWWA C905	Polyvinyl Chloride (PVC) Pressure Pipe 14-in Through 48-in for Water Distribution
ASTM D 2584	Test Method for Ignition Loss of Cured Reinforced Resins
PPI Technical Report TR 3/4	Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials
AWWA Manual M23	PVC Pipe - Design and Installation

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings: The Contractor shall submit shop drawings of pipe, fittings, and appurtenances in accordance with the requirements in Section 01 33 20 –Submittal Procedures. Manufacturer's literature for metallic locating tape.
   1. Showing dimensions and details of pipe joint fittings, fitting specials, valves and appurtenances.

2. Detailed layout, spool or fabrication drawings showing pipe spools, spacers, adapters, connectors, fittings and pipe supports not indicated in the Contract Documents.
3. Manufacturer's product data and samples of all materials proposed for use on the work.

B. Certifications: A certified affidavit of compliance for pipe and other products or materials under this Section.

C. Test Reports:
1. Hydrostatic proof test reports.
2. Sustained pressure test reports.
3. Burst strength test reports.

D. The Contractor shall be responsible for performing and paying for sampling and testing as necessary for the certifications.

E. Owner's Manual
1. Manufacturer's technical data and installation instructions.
2. Manufacturer's certificates of compliance indicating that all materials provided under this Section meet the requirements of the Contract Documents.

1.4 QUALITY ASSURANCE

A. Inspection: Pipe shall be subject to inspection at the place of manufacture.

B. During manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

C. Tests: Materials used in manufacture of the pipe shall be tested in accordance with the requirements of this Section and the referenced standards, as applicable.

D. The Contractor shall perform said material tests. The Engineer shall have the right to witness testing; provided that the Contractor's schedule is not delayed for the convenience of the Engineer.

E. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished as a part of the Work.

1.5 INSPECTION

A. All pipe may be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards as supplemented by the requirements herein. The Contractor shall notify the District in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the District shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

1.6 SOURCE QUALITY CONTROL

A. Except as modified herein, pipe shall be tested in accordance with the requirements of this Section and AWWA C900 or C905, as applicable.
   1. The Contractor shall perform said material tests in accordance with the requirements of the Contract Documents. The Owner shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule will not be delayed for the convenience of the Owner.
   2. All expenses incurred in obtaining samples for testing shall be borne by the Contractor at no increased cost to the Owner.
   3. In addition to those tests specifically required, the Owner may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. PVC pressure pipe (4-inch through 12-inch) shall conform to the applicable requirements of ANSI/AWWA C900 subject to additional requirements herein.

B. PVC pressure pipe (14-inch through 48-inch) shall conform to the applicable requirements of ANSI/AWWA C905 subject to additional requirements herein.

C. Each piece of pipe and fitting shall be clearly labeled to identify its size, pressure class and manufacture date.

2.2 PIPE DESIGN CRITERIA

A. General: PVC pressure pipe shall be designed in accordance with the requirements of ANSI/AWWA C900 and ANSI/AWWA C905.

B. Polyvinyl Chloride (PVC) pipe shall have outside diameter dimensions conforming to cast iron pipe and shall be the diameter and class indicated on the plans. The pipe shall meet the pressure class requirements indicated on the drawings, and shall meet the requirements of Table 2 of AWWA C900 or C905 as applicable.

C. PVC pipe shall be provided in standard 20 foot lengths, unless otherwise specified, detailed or required on the approved plans. Shorter lengths, up to 10 feet, will be permitted when authorized by the Engineer. Field cut lengths of pipe used as closures may not be shorter than 2 feet in length, and must be approved by the Engineer.

2.3 PIPE

A. The pipe shall be of the diameter and pressure class specified or shown, shall be furnished complete with rubber gaskets, and all specials and fittings shall be provided as required in the Contract Documents. Unless otherwise noted, diameters shown in the Contract Documents shall refer to Cast-Iron Pipe Equivalent Outside Diameters (CIOD), conforming to the requirements of AWWA C900 or C905 as appropriate.

B. Additives and Fillers: Unless otherwise allowed in alternate qualification procedures of PPI-TR3, compounds which have a Hydrostatic Design Basis (HDB) of 4000 psi at 73.4 degrees F and for water shall not contain additives and fillers that exceed the recommended values in Table 1, Part Y of PPI-TR3 (e.g., allowable content range for calcium carbonate is 0.0-5.0 parts per hundred of resin). If requested by the Engineer, the additive and filler content shall be determined using the pyrolysis method as specified in ASTM D 2584.

C. Color: Pipe for use in potable or culinary water systems, or directly attached to potable or culinary water systems shall be white or blue. Pipe used in irrigation, reuse, utility water or any other non-potable use shall be purple.

D. Joints: Except where specifically noted or where designated as "fusible PVC," joints for buried PVC pipe shall be either an integral bell manufactured on the pipe or a separate coupling both employing a rubber ring joint. The bell and coupling shall be the same thickness as of the pipe barrel, or greater thickness. The sealing ring groove in the coupling shall be of the same design as the groove in cast iron fittings and valves available from local water works supply distributors. No restrained joint PVC pipe will be allowed. When the spigot end of pipe is to be inserted into a mechanical joint fitting, the beveled end of the pipe shall be removed prior to insertion. Solvent weld joints are not permitted.

E. Joint shall be sealed with an elastomeric gasket meeting the requirements of ASTM F 477 and ASTM D3139. Gaskets and lubricants shall be made from materials that are compatible with the plastic material and with each other when used together. They shall not support the growth of bacteria and shall not adversely affect the potable qualities of the water that is to be transported. One elastomeric gasket shall be furnished with each length of bell-end pipe.

F. Joint Deflection: Deflection at the joint shall not exceed 1.5 degrees or the maximum deflection recommended by the manufacturer. No deflection of the joint shall be allowed for joints which are over-belled or not belled to the stop mark.

2.4 FITTINGS

A. Fittings shall be ductile iron fittings meeting the requirements of Section 02565 – Ductile Iron Pipe and of AWWA C110 and/or AWWA C153. Fittings shall be wrapped in polyethylene encasement per AWWA C-105 and all hardware shall be coated with a non-oxide grease.

B. Where fabricated PVC fittings are specifically required:
   1. Fittings (4-inch through 12-inch) shall conform to the applicable requirements of ANSI/AWWA C900 subject to additional requirements herein.
   2. Fittings (14-inch through 48-inch) shall conform to the applicable requirements of ANSI/AWWA C905 subject to additional requirements herein. All fabricated PVC

fittings 14-inch and larger shall include fiberglass reinforcement permanently bonded to the outside surfaces of the fitting.

C. All ductile iron fittings shall be lined in accordance with Section 33 41 05 – Ductile Iron Pipe. Fittings shall be cement-mortar lined ductile, coated with a bituminous material and shall conform to the requirements of AWWA Standard C110 and C111 with a minimum rated working pressure of 250 psi. The cement lining shall conform to the requirements of AWWA Standard C104.

D. Each fitting shall be clearly labeled to identify its size and pressure class.

E. All fittings and valves shall be restrained against thrust forces by concrete thrust blocks furnished and installed as indicated in the Drawings.

2.5 TRACER WIRE

A. Tracer wire shall be N0. 12 AWG copper wire, PVC jacketed for underground services.

2.6 SERVICE SADDLES

A. Bronze bodied saddles with double bronze straps or full circle body clamp double bolted to each side of the saddle shall be used on pipe sizes 4 inch through 12 inch. The saddle body shall be manufactured from cast bronze in accordance with ASTM B62 or B584 and AWWA C800. The single strap shall have double bolts on each end of the strap to connect it to the bronze saddle. The ears of the strap shall turn inward and rest against the inside of the strap. The gasket shall be Buna N. The saddle shall be threaded with 1 inch or 2 inch iron pipe threads.

PART 3 - EXECUTION

3.1 GENERAL

A. Laying, jointing, testing for defects and for leakage shall be performed in the presence of the Engineer, and shall be subject to approval before acceptance. Material found to have defects will be rejected and the Contractor shall promptly remove such defective materials from the Site.

B. Installation shall conform to the requirements of AWWA M23, instructions furnished by the pipe manufacturer, and to the supplementary requirements herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

C. The Contractor shall install all the pipe closure sections, fittings, valves and appurtenances shown on the approved plans, including bolts, nuts, gaskets and joining materials.

D. The Contractor shall excavate sufficiently in advance of pipe laying operations to enable the alignment and profile to be revised to clear existing utilities and to align with existing connection points.

E. PVC pipe which has been gouged shall not be used. PVC pipe which has received minor scratches during handling may be used solely at the discretion of the Engineer.

F. The Contractor shall maintain the interior of the pipe clean, sanitary and free from foreign materials. At all times when the work of installing pipe is not in progress, all openings into the pipe and the ends of the pipe in the trenches shall be kept tightly closed to prevent the entrance of animals and foreign materials. To prevent unwanted water intrusion, open ends of pipe shall be closed temporarily with a watertight bulkhead.

G. Do not install any pipe contaminated with a petroleum product (inside or outside).

H. Do not install any pipe that shows evidence of exposure to sunlight, age, surface deterioration, or other physical damage. The decision of the Engineer shall be final as to the acceptability of the pipe to be installed.

3.2 HANDLING AND STORAGE

A. Handling: Pipe, fittings and accessories shall be carefully inspected before and after installation and those found defective shall be rejected. Pipe and fittings shall be free from fins and burrs. Before being placed in position, pipe, fittings, and accessories shall be cleaned, and shall be maintained in a clean condition. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings or any other material be dropped or dumped into trenches. The pipe shall be hoisted with mechanical equipment using a cloth belt sling or a continuous fiber rope which avoids scratching the pipe. A chain is not permitted. Pipes up to 6 inches in diameter can be lifted by hand.

B. Storage: Pipe should be stored, if possible, at the Site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to bell ends of the pipe. Pipe shall be supported uniformly while being stored in such a way as to prevent sagging or bending and be protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Gaskets should be stored in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.3 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of Section 31 23 00 – Earthwork. Care shall be taken to ensure that pipe zone material is compacted and in full contact with the haunches of the pipe and that the pipe is fully supported.

3.4 INSTALLATION

A. Bell-and-spigot pipe shall be laid with the bell end pointing in the direction of laying. Pipe shall be graded in straight lines, taking care to avoid the formation of any dips or low points. Pipe shall not be laid when the conditions of trench or weather are unsuitable. At the end of each day's work, open ends of pipe shall be closed temporarily with wood blocks or bulkheads.

B. Pipe shall be supported at its proper elevation and grade, care being taken to secure firm and uniform support. Wood support blocking will not be permitted. The full length of each section of pipe and fittings shall rest solidly on the pipe bed, with recessed excavation to accommodate bells, joints, and couplings. Anchors and supports shall be provided where indicated and where necessary for fastening work into place. Fittings shall be independently supported.

C. Short lengths of pipe shall be used in and out of each rigid joint or rigid structure. Piping that does not allow sufficient space for proper installation of jointing material shall be replaced by one of proper dimensions. Blocking or wedging between bells and spigots will not be permitted.

D. Joints shall be installed according to manufacturer's recommendations. Trenches shall be kept free of water until joints have been properly made. The maximum combined deflection at any coupling shall be in accordance with the manufacturer's recommendations.

E. Pipe shall be cut by means of saws, power driven abrasive wheels, or pipe cutters, which will produce a square cut. No wedge-type roller cutters will be permitted. After cutting, the end of the pipe shall be beveled using a beveling tool, portable type sander, or abrasive disc.

F. Pipe end shall be secure at all times and care shall be taken to prevent any foreign object, dirt, rocks, debris, rubbish, tools, etc from entering the pipe. Pipe end shall be capped at the end of each days laying operations. Provided required minimum separation from adjacent utilities are satisfied.

G. Install PVC pipe such that the indelible identification strip markings on each pipe section are continuously aligned for the total length of the pipeline being installed. Orient the strip marking upward to the 12 o'clock position (top) of the trench opening.

H. Assemble the pipe joint using the lubricant supplied by the manufacturer. Ensure lubricant is NSF certified for use in potable water systems. Insert the spigot end into the bell or coupling to the proper insertion mark. Check that the elastomeric ring has not left the groove during assembly by passing a feeler gauge around the completed joint.

I. Tapping saddles shall be installed a minimum of 5 feet from the edge of the saddle to any pipe joint or other saddle. Multiple taps of 6 inches or larger shall not be made in the same length of pipe without the approval of the Engineer.

3.5 INSTALLATION OF METALLIC LOCATING TAPE

A. Polyvinyl chloride pipelines shall be provided with a metallic locating tape laid along the centerline of the pipe trench at a depth of 18 inches below finished grade **OR** above top of pipe. The Contractor shall furnish manufacturer's literature, completely describing the tape proposed to be furnished. No tape shall be used prior to receipt of written approval of the Engineer.

3.6 INSTALLATION OF LOCATOR WIRE

A. Polyvinyl chloride pipelines shall be provided with locator wire secured to the pipe with surface connections provided at all valve boxes and hydrants and as required to maintain a maximum distance between connections of no greater than 500 feet. Tracer wire shall be laid along the top of the pipe and held in place with ties or hitches. The ties or hitches shall be spaced not more than 10 feet apart. The copper wire is to be used in the future as a means of locating the pipe with an electronic-type pipe locator.

3.7 FIELD TESTING AND DISINFECTION

A. Field testing shall conform to the requirements of Section 33 13 00 – Water Pipeline Testing and Disinfection as applicable.

END OF SECTION

SECTION 33 05 16
PRECAST CONCRETE MANHOLES AND VAULTS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide precast concrete manholes, catch basins, drop inlets, potable water vaults; meter vaults, and other pre-cast concrete structures complete and in place, in accordance with the Contract Documents.

1.2 RELATED SECTIONS

A. Section 03 30 00 – Cast-in-place Concrete

B. Section 31 23 00 – Earthwork

1.3 SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards

ASTM A 48	Gray Iron Castings
ASTM C 150	Portland Cement
ASTM C 443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478	Precast Reinforced Concrete Manhole Sections
ASTM C 877	Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
ASTM C 923	Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
ASTM C 990	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

1.4 CONTRACTOR SUBMITTALS

A. General: Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop Drawings:
1. Show dimensions, locations, lifting inserts, reinforcement, and joints.
2. Structural design calculations for vaults and boxes shall be stamped and signed by a structural engineer registered in the state of Utah.

C. Manufacturer's Certification for Manholes and Vaults: Written certification that the structure complies with the requirements of this Section.

D. Manufacturer's Test Results: Pull out force for manhole steps.

1.5 QUALITY ASSURANCE

A. Inspection: After installation, the Contractor shall demonstrate that manholes and vaults have been properly installed, level, with water-tight joints, at the correct elevations and orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

B. Any precast concrete which arrives on site with voids, cracked, or damaged, or is cracked or damaged during installation shall be cause for rejection. Contractor shall remove precast section(s) from the project site and replace with new undamaged sections at no additional cost to OWNER.

1.6 DELIVERY, STORAGE AND HANDLING

A. Handle precast units in positions consistent with their shape and design. Lift and support only from the support points indicated on the shop drawings.

B. Embedded Lifting or Handling Devices: Capable of supporting units in positions anticipated during manufacturing, storage, transportation and installation.

C. Block and brace units during storage. Provide lateral bracing which is sufficient to prevent bowing and/or warping and will not inhibit curing of the exposed surfaces.

PART 2 - PRODUCTS

2.1 MANHOLES

A. The Contractor shall provide precast manhole sections and conical sections conforming to ASTM C 478 and the requirements of this Section. Cement used in manufacturing the manholes shall be Type II modified portland cement in accordance with ASTM C 150

B. Adjusting rings shall be standard items from the manufacturer of the manhole sections. Minimum wall thickness of rings shall be 4-inches if steel reinforced and 6-inches if not reinforced.

C. Axial length of sections shall be selected to provide the correct total height with the fewest joints. Joints shall be minimized and shall be located as close as possible to the top of the structure to help minimize opportunity for groundwater infiltration.

D. Conical sections shall have an eccentric shape and shall be designed to support cast iron frames and covers under an H-20 loading, unless indicated otherwise.

E. Design Criteria: Manhole walls, transitions, conical sections, and base shall be designed per ASTM C 478 for the depths indicated and the following:

1. AASHTO H-20 loading applied to the cover.
2. Unit weight of soil of 120 pcf located above all portions of the manhole.
3. Lateral soil pressure based on saturated soil producing 100 pcf acting on an empty manhole.
4. Internal fluid pressure based on unit weight of 63 pcf with manhole filled from invert to cover with no balancing external soil pressure.
5. External pressures and uplift forces due to groundwater elevations 2 feet below finish grade.
6. Dead load of manhole sections fully supported by the base and transition.
7. Additional reinforcing steel in walls to transfer stresses at openings.
8. The minimum clear distance between the edges of any 2 wall penetrations shall be 12-inches or one-half of the diameter of the smaller penetration, whichever is greater.

F. Joints shall have lipped male/female ends which shall provide uniform and continuous interior wall surfaces and shall be watertight. All joints (including joints between adjusting rings and manhole structure, other adjusting rings and frame and cover) shall be sealed with a preformed flexible sealant conforming to ASTM C 990.

G. Raw Sewage, Plant Drain, drain manholes, plant effluent and all vaults shall also have each joint wrapped with an external joint sealant meeting ASTM C 877. Concrete for base and channel formation shall be 4000 psi concrete conforming to Section 03 30 00 – Cast-In-Place Concrete.

H. Barrel section to sewer pipe (Raw sewage, plant drain, drain, and plant effluent) connections shall be sealed with flexible, resilient connectors complying with ASTM C 923 and appropriate for the pipe material being used. Mechanical devices shall be stainless steel.

I. Manhole steps shall be comprised of 1/2-inch grade 60 steel reinforcement rod encased in polypropylene copolymer plastic. Steps shall have tread width of 14-inches. Furnish test results demonstrating step capability to resist a pull out force of 2200 pounds.

J. Manhole riser sections shall be greater than 12 inches in height.

K. Manhole Manufacturers, or Equal
1. AMCOR Precast, Ogden, Ut
2. Geneva Pipe, Orem, Ut

2.2 FRAMES AND COVERS

A. Castings: Castings for manhole frames, covers, and grates shall be non-rocking with machined flat bearing surfaces, and shall conform to the requirements of ASTM A 48, Class 30. Unless otherwise indicated, cast iron covers and frames shall be heavy traffic type, 30 inches in diameter. Covers shall have cleated surfaces with pick holes and shall be ventilated in improved areas and have a solid lid design in landscape or native areas.

B. Manhole covers shall be with embossed with lettering saying "Sewer", "Storm Sewer", “Plant Drain”, or “Water”.

C. All frames and covers shall be designed for H-20 traffic loading. Grates and curb inlets in traffic areas shall be designed for H-20 traffic loading.

D. Castings Manufacturers, or Equal
   1. D & L Supply
   2. Neenah Foundry Co.
   3. Olympic Foundry

2.3 VAULTS

A. The Contractor shall provide precast vaults designed for the indicated applications and of the sizes indicated.

B. The minimum structural member thickness for vaults shall be 5-inches. Cement shall be Type V or Type II modified portland cement as specified in ASTM C 150. The minimum 28-day concrete compressive strength shall be 4,000 psi. All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by ACI 318.

C. Design Loading: Vaults in areas subject to vehicular traffic shall be designed for H-20 traffic loading. Vaults in other areas shall be designed for a vertical live load of 300 psf. Lateral loads on vaults in all areas shall be calculated from:
   1. L = 90 h, plus surcharge of 240 psf in areas of vehicular traffic
   2. Where L = loading in psf
   3. h = depth of fill in feet.

D. Design loading shall also take into account the lateral and uplift pressure resulting from a groundwater elevation 2 feet below existing grade.

E. Where joints are designed in pre-cast concrete vaults, such joints shall be interlocking to secure proper alignment between members and prevent migration of soil through the joint. Structural sections at joints shall be sized sufficiently to reinforce the section against localized distress during transportation and handling and against excess contact bearing pressures through the joint. All openings through the precast structure shall be reinforced to transfer loads.
   1. Joints shall be sealed watertight. All joints (including joints between adjusting rings and manhole structure, other adjusting rings and frame and cover) shall be sealed with a preformed flexible sealant conforming to ASTM C 990. In addition, all joints shall be wrapped with an external joint sealant meeting ASTM C 877.

F. Where openings for access to the vault are required, the full clear space opening indicated shall be provided, without obstructions from brackets or supports. For large openings where brackets or supports are designed to protrude into the opening for support of required covers, such brackets or supports shall be designed to be easily removed and replaced with a minimum of effort and without cutting or welding.

G. Covers for access openings shall be provided. Frames for covers shall be fabricated from aluminum, and shall be integrally cast into the vault concrete sections. All covers shall be tight fitting to prevent the entrance of dirt and debris. Where edge seams are permitted, no gaps greater than 1/16-inch between edges will be accepted. All covers, except round, heavy-weight, cast iron manhole covers, shall have securing mechanisms to hold the covers firmly in place against the effects of repetitious live loads such as pedestrian or vehicle traffic.

H. Where penetrations of the pre-cast concrete vaults are required for piping, conduit, or ducts, such penetrations shall be accommodated through pre-cast openings or wall sleeves, as indicated. Storm drain structures may also use thin-wall knock-out sections. All openings for penetrations shall be smooth and free of surface irregularities and without exposed steel reinforcing. With the exception of vaults on pressurized water system, vaults need not be designed to resist thrust from piping passing through the vault.

I. Lifting holes shall be plugged with a precast concrete plug sealed with a non-shrink grout.

J. Vault Manufacturers, or Equal
   1. AMCOR Precast, Ogden, Ut
   2. Geneva Pipe, Orem, Ut

2.4 FABRICATION

A. Maintain plant records and quality control program during fabrication of structural precast concrete sections. Make all quality control records available to ENGINEER upon request.

B. Use molds that are rigid, and constructed of material that will result in uniform finished surfaces.

C. If self consolidating concrete is not used, thoroughly vibrate concrete to ensure proper consolidation, elimination of cold joints, and to minimize trapped air on at the concrete surface.

D. Fabricate and provide the required lifting devices which are compatible with embedded components.

E. Ensure reinforcing steel, anchors, inserts, plates, angle and other cast-in items are sufficiently embedded, properly secured, and correctly located. Ensure the reinforcing steel is properly supported to prevent movement or shifting during fabrication. Inadequate concrete cover over reinforcing shall be cause for rejection.

F. Cure precast concrete sections under identical conditions to develop specified concrete quality.

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to accepting manholes on site, ensure that manhole meet the requirements of these specifications, are constructed of the correct materials, and are not cracked or damaged in any other way.

B. Pre-cast concrete sections shall be transported and handled with care in accordance with the manufacturer's written recommendations. Where lifting devices are provided in pre-cast sections, such lifting devices shall be used as intended. Where no lifting devices are provided, the Contractor shall follow the manufacturer's recommendations for lifting procedures to provide proper support during lifting.

C. Buried pre-cast concrete vaults and manholes shall be assembled and placed in excavations on properly compacted soil foundations as indicated. Pre-cast concrete vaults and manholes shall be set to grade, plumb and level, and oriented to provide the required dimensions and clearances from pipes and other structures.

D. Prior to backfilling vaults, pipe and conduit penetrations and other, openings shall be sealed with polyurethane sealant or as indicated in the drawings. With the authorization of the Engineer, grout or a closed-cell flexible insulation may be used as filler material prior to placing a final bed of polyurethane sealant.

3.2 MANHOLES

A. Connect pipe to manhole with flexible connection, as recommended by connection manufacturer. Provide a pipe joint or additional flexible connection 18 inches from the outside of the manhole. Grout around pipe after installation is complete, unless otherwise indicated. All connections shall be watertight.

B. Place top section, cone section or flat slab on top riser section, with the opening positioned over the steps. Top of cone section or flat slab shall be from 10 to 18 inches below finished grade.

C. Install grade rings as required to adjust top of lid and frame to match finish grade elevation. Maximum height of grade rings shall be 12 inches. Maximum number of grade rings shall be two.

D. In paved areas and as indicated in the plans, concrete collars shall be constructed around manhole covers as indicated. Collars shall be of 4000 psi concrete. Collars shall be constructed after pavement has been placed.

E. Steps shall be cast-in-place or vibrated into green concrete.

F. Steps shall be installed 12-inches on centers vertically, not more than 1/2 inch out of plumb. The top step shall be no more then 12-inches below the manhole cover.

G. After manhole base has been completed, furnish and install temporary pipe plugs to seal all interior pipe opening. Plugs shall remain in place until final review and acceptance of completed pipeline. Plugs shall then be removed and shall be property of Contractor.

3.3 QUALITY CONTROL

A. Manholes shall be tested and accepted per the requirements of Section 33 08 00 – Gravity Piping Testing and Inspection.

B. Do not install precast concrete units until concrete has attained its design compressive strength.

END OF SECTION

SECTION 33 05 19
PRESSURE PIPING TIED JOINT RESTRAINT SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide Chlorinated Polyvinyl Chloride (CPVC) pressure pipe, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 40 05 00 - Piping, General, apply to the WORK of this Section.

PART 2 - PRODUCTS

2.1 PIPE MATERIAL

A. CPVC pipe shall be in accordance with ASTM F 441 - Chlorinated Poly (Vinyl Chloride) (CPVC), Plastic Pipe, Schedules 40, and 80, from all new compounds, meeting the requirements of Class 23447 per ASTM D 1784 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (PVC) Compounds. CPVC pipes shall be Schedule 80 pipe, unless otherwise indicated. CPVC material shall be listed as compliant with NSF Standard 61.

2.2 PIPE JOINTS

A. Pipe joints shall be solvent-welded with solvent cement in accordance with ASTM F 493 - Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings, and with primer in accordance with ASTM F 656 - Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings. Screwed joints which are necessary to match up to threaded valves or fittings shall be made up with appropriate thread sealant, either paste or tape. Flanged joints shall be made with solvent-welded CPVC flanges, drilled to ANSI/ASME B 16.5 - Pipe Flanges and Flanged Fittings, Class 150, unless otherwise indicated. For CPVC or PVC pipe used in chemical service, solvent welded joints shall be done using IPS Corp Type 724 cement or another cement certified by the manufacturer for chemical service.

2.3 FITTINGS

A. Solvent-Welded Fittings: Solvent-welded fittings shall be Schedule 80 CPVC fittings in accordance with ASTM F 439 - Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

B. Threaded Fittings: Threaded fittings shall be Schedule 80 CPVC fittings in accordance with ASTM F 437 - Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

C. Flanged Fittings: Flanged fittings shall be fabricated Schedule 80 CPVC fittings with 150 lb. flanges to ANSI/ASME B 16.5. Gaskets shall be ANSI 150 lb. full face, 1/8-inch thick Neoprene

for water or wastewater service. Gasket material for chemicals shall be suitable for use with the chemical service.

2.4 COATINGS

A. Outside of CPVC piping and fittings shall be coated to conform to the requirements of Section 09 90 01 – Protective Coatings.

PART 3 - – EXECUTION

3.1 INSTALLATION

A. General: CPVC pipes shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. The entire installation shall be acceptable to the ENGINEER. It is recommended that the CONTRACTOR obtain the assistance of the pipe manufacturer's field representative to instruct the pipe fitters in the correct installation and support of all CPVC piping.

B. Supports and Anchors: Piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 40 00 01 - Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences. Where piping support is metallic, Contractor shall provide and install unicusion or other acceptable piping protective shield to encompass the entire portion of pipe in contact with the support material.

C. Valves and Unions: Unless otherwise indicated, connections to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection. Valves and flanges attached to CPVC pipe shall be provided with adequate supports.

3.2 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, flushed clean of any debris or dust, and straightened, if not true. Ends of threaded pipes shall be reamed and filed smooth. Pipe fittings shall be equally cleaned before assembly.

3.3 PIPE JOINTS

A. Threaded Joints: Pipe threads shall conform to ASTM F 1498-Taper Pipe Threads 600 for Thermoplastic Pipe and Fittings, and shall be full and cleanly cut with sharp dies or molded. Joints shall be mode with Teflon tape or thread sealant.

B. Solvent-Welded Joints: Solvent-welded joints shall be made with fresh primer and solvent cement on clean, dry pipe ends. The primer and cement cans shall be kept closed at all times

and the joints shall be made up at the recommended ambient temperatures, to the pipe or cement manufacturer's written recommendations. Pipe ends shall be inserted to the full depth of the socket.

C. Flanged Fittings: Flanged joints shall be made with gaskets and Type 316 stainless steel bolts and nuts. Care shall be taken not to over-torque the bolts, in accordance with the manufacturer's written recommendations.

3.4 INSPECTION AND FIELD TESTING

A. Inspection: Finished installations shall be carefully inspected for proper joints and sufficient supports, anchoring, interferences, and damage to pipe, fittings, and coating. Any damages shall be repaired by the Contractor to the satisfaction of the ENGINEER.

B. Field Testing: The CONTRACTOR shall allow adequate time for the solvent cement joints to cure. Curing time shall be per the solvent cement manufacturer's recommendation. Prior to enclosure or burying, piping systems shall be pressure tested as required in the Piping Schedule for a period of not less than one hour, without exceeding the tolerances listed in the Piping Schedule. CAUTION – DO NOT use air or gas for testing CPVC pipe. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The CONTRACTOR shall furnish all test equipment, labor, materials, and devices.

C. Leakage shall be determined by loss of pressure. Fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

D. Leaks shall be repaired by the Contractor to the satisfaction of the ENGINEER and the system shall be re-tested as required until no leaks are found.

END OF SECTION

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SECTION 33 08 00
GRAVITY PIPING TESTING AND INSPECTION

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall perform all pipeline flushing and testing, complete, for gravity piping systems or other yard piping systems as required in the Contract Drawings, and as specified herein; in accordance with the requirements of the Contract Documents.

B. The Owner will provide flushing water and the Contractor shall be responsible for conveying it to the point of usage and also for disposal, as required, of water used in the flushing operations.

C. For the purpose of this specification, gravity piping, sewer or gravity sewer piping refers to all pipes with flows that are driven by gravity in an open channel flow condition and convey liquids associated with the treatment plant processes and byproducts (e.g. plant drain, waste, drains, raw sewage, etc).

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ASTM F1417	Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
ASTM C924	Standard Practice for Testing Concrete Pipe Sewer Line by Low-Pressure Air Test Method
ASTM C1244	Standard Test Method for Concrete Sewer Manholes by Negative Air Pressure (Vacuum) Test Prior to Backfill
UNI-B-6	Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe

1.3 CONTRACTOR SUBMITTALS

A. The Contractor's proposed plans for testing, and for water conveyance, control, and disposal, shall be submitted in writing. The Contractor shall also submit minimum 48-hour advance written notice of its proposed testing schedule for review and concurrence of the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS REQUIREMENTS

A. Temporary valves, plugs, bulkheads, and other air pressure testing and water control equipment and materials shall be provided by the Contractor subject to the Engineer's

review. No materials shall be used which would be injurious to pipeline structure and future function. Air test gages shall be laboratory-calibrated test gages and shall be recalibrated by a certified laboratory at the Contractor's expense prior to the leakage test, if required by the Engineer.

PART 3 - EXECUTION

3.1 GENERAL

A. All testing operations shall be performed in the presence of the Engineer.

B. All water required for cleaning and testing of the sewer pipes shall be furnished by the Contractor.

3.2 CLEANING

A. Do not allow dirt, grease, mud, groundwater, tools, equipment and all other foreign matter to enter the pipe at any point during construction.

B. All pipes shall be completely flushed at a rate with water velocities no less than 4.0 feet per second for pipes up to 12 inches in diameter and 3.0 feet per second for all other pipes. For large diameter pipes, alternate methods, including pigging, or cleaning the pipe may be proposed by the Contractor, subject to the approval of the Engineer, provided proposed method will provide a clean pipe equivalent to flushing as determined by the Engineer.

C. No debris, rubbish, dirt, rocks, or other foreign material shall be permitted to enter downstream sections of the pipeline or system.

D. Furnish, install and permanently remove all cross-connections, piping, valving, ports, etc required to complete the cleaning process. Obtain approval of the Engineer prior to adding any components to the pipeline.

3.3 TESTING OF PIPING

A. General: All gravity sewer pipes and service laterals shall be air tested and mainlines shall be checked for deflection, as specified. All manholes, vaults and boxes directly conveying flows shall be tested for leakage, as specified. Manholes and piping shall be tested following backfill placement. All leakage tests shall be completed and approved prior to the placement of permanent surfacing. When leakage exceeds the amount allowed by the Specifications, the Contractor shall locate the leaks and make the necessary repairs or replacements required to eliminate the leakage. Any individually detectable leaks shall be repaired, regardless of the results of the tests.

B. Leakage Tests: Gravity sewer systems shall be tested for leakage as follows:
   1. Air Pressure Test - Gravity sewers shall be air pressure tested in accordance with UNI-B 6 and/or ASTM F1417 as outlined below.
      a. The Contractor shall furnish all materials, equipment and labor for making an air test. Air test equipment shall be approved by the Engineer.

b. The Contractor may conduct an initial air test of the sewer main line after densification of the backfill but prior to installation of lateral connection sewers. Such tests will be considered to be for the Contractor's convenience and need not be performed in the presence of the Engineer.

c. Each section of sewer shall be tested between successive manholes by plugging and bracing all openings in the main sewer line and the upper ends of all lateral connection sewers. Prior to any air pressure testing, all pipe plugs shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released, the leaks eliminated, and the test procedure started over again.

d. Test pressure shall be 4.0 psig, unless groundwater elevation exceeds the invert elevation of the pipe. Where the normal groundwater elevation exceeds the invert elevation of the new pipe, the test pressure shall be adjusted for back pressure created by the groundwater. The new test pressure shall be determined by:

$$P_t = 4.0 + \frac{H}{2.35} \leq 9.0 \text{ psig}$$

e. Where P_t is the new test pressure and H is the difference in feet between the groundwater elevation and the lowest invert elevation of the pipe being tested. In no case shall the test pressure exceed 9.0 psig or the maximum pressure allowed by the pipe manufacturer.

f. After a manhole to manhole reach of pipe has been backfilled and cleaned, and the pneumatic plugs are checked, the plugs shall be placed in the line at each manhole and inflated to manufacturer's recommended inflation pressure. Low pressure air shall be introduced into this sealed line until the internal air pressure reaches test pressure. At least two minutes shall be allowed for the air pressure to stabilize. After the stabilization period minimum pressure (at the beginning of test time shall be test pressure minus 0.5 psig), the air hose from the control panel to the air supply shall be disconnected.

g. For pipe diameters 4"-36", the portion of line being tested shall be termed "Acceptable" if the allocated line pressure decreases less than 1.0 psi in the time shown for the given diameters and lengths in Table 1.

h. For pipe diameters greater than 36", the portion of line being tested shall be termed "Acceptable", if the allocation line pressure decreases less than 0.5 psi in the time shown for the given diameters and lengths in Table 2.

i. Required test times for lines consisting of multiple pipe diameters shall be determined in accordance with UNI-B-6 and or ASTM F1417.

j. If the installation fails to meet these requirements, the Contractor shall determine the source of leakage. He shall perform a leak location test and then repair or replace all defective materials and/or workmanship. This work shall be completed at no additional cost to the Owner.

Table 1
Low Pressure Air Test Times for 1.0 PSig Pressure Drop

Pipe Diameter (in.)	Minimum Time for 1.0 PSIg Pressure Drop (min:sec)	Pipe Length for Minimum Time (ft.)	Test Time for Pipe Length in Excess of Minimum (sec.)
4	03:47	597	.380 L
6	05:40	398	.854 L
8	07:33	298	1.520 L
10	09:27	239	2.374 L
12	11:20	199	3.418 L
15	14:10	159	5.342 L
18	17:00	133	7.692 L
21	19:50	114	10.470 L
24	22:40	99	13.674 L
27	25:30	88	17.306 L
30	28:20	80	21.366 L
33	31:10	72	25.852 L
36	34:00	66	30.768 L

Table 2
Low Pressure Air Test Times for 0.5 PSIg Pressure Drop

Pipe Diameter (in.)	Minimum Time for 0.5 PSIg Pressure Drop (min:sec)	Pipe Length for Minimum Time (ft.)	Test Time for Pipe Length in Excess of Minimum (sec.)
42	19:50	57	20.939 L
48	22:40	50	27.349 L
54	25:30	44	34.614 L
60	28:30	40	42.733 L
66	31:10	36	51.707 L
72	34:00	33	61.535 L
78	36:50	31	72.219 L
84	39:40	28	83.756 L
90	42:30	27	96.149 L
96	45:20	25	

C. Deflection Test: All flexible and semi-rigid main line pipe shall be tested for deflection, joint displacement, or other obstruction by passing a rigid mandrel through the pipe by hand, not less than 30 days after completion of the trench backfill, but prior to permanent surfacing. The mandrel shall be a full circle, solid cylinder, or a rigid, non-adjustable, odd-numbered leg (9 leg minimum) steel cylinder, approved by the Engineer as to design and manufacture. The circular cross section of the mandrel shall have a diameter of at least 95 percent of the specified average inside pipe diameter of the pipe and the minimum length of the circular

portion of the mandrel shall be equal to the nominal diameter of the pipe. Obstructions encountered by the mandrel shall be corrected by the Contractor.

D. Video Inspection: After the sewer pipe has been installed and cleaned; and the trench has been backfilled, the sewer pipe shall be visually inspected by video camera to locate defects in the sewer pipe. Video Inspection shall be performed by an independent testing agency acceptable to the Owner. All sewer pipes shall be video inspected.

1. Notify the Engineer, 48 hours prior to any televised inspections.
2. The inspection shall be in digital video format, saved to an electronic media and shall be given to the Engineer for review and final records
3. The Contractor shall ensure safe access to each manhole as required by the testing agency.
4. Video equipment shall include a pipe inspection video camera with the following capabilities: panorama tilt, radial viewing, pans plus and minus 75 degrees, rotates 360 degrees, and has optical zoom from 6 or less inches to infinity. Equipment shall produce a high quality, full color video image.
5. Video equipment shall be equipped with a device that can accurately measure the depth of any ponding encountered in the pipe. Measuring device shall be clearly visible in the video image.
6. The video equipment shall have an accurate footage counter accurate to within 1 foot per 500 foot of pipe. Footage shall be continuously displayed on the video at all times.
7. Pipelines shall be cleaned and flushed immediately prior to video inspection. Pipelines that were cleaned and flushed more than 24 hours prior to video inspection shall be cleaned and flushed again. All dirt/debris, including pipe grease, in the line which could cover a defect shall be removed.
8. Jetting of the lines in conjunction with the video inspection is prohibited.
9. If during the video inspection, foreign material which prohibits an acceptable video inspection is discovered the line shall be cleaned and video inspected again.
10. The video camera shall travel through the pipe at a maximum rate of travel of 30 feet per minute. Video shall be continuous for each pipe segment between manholes or other access points.
11. The video camera shall pause at each tee, lateral or other connection and the camera shall be rotated and tilted to provide an image of the branch for inspection. The image shall remain clear and in focus at all times while zooming to the full extent of the camera. The camera operator shall stop at each fitting and change in pipe type and complete a 360 degree view of the fitting at a rate slow enough to identify any defects.
12. Glare shall be avoided and shall not interfere with viewing the pipe segment.
13. Provide DVDs or CDs with labels indicating project number, segment number, date televised, date submitted, starting manhole number, ending manhole number, pipe diameter, pipe length and street name.
14. Lines to be video inspected shall be flushed within 24 hours prior to beginning of inspection.
15. The video inspection shall be used to identify defective construction such as sags, debris, separated joints, etc. Any Work not conforming to the Specifications or Drawings shall be promptly removed, replaced and retested at no cost to the Owner. The Engineer shall make all final determinations if the severity of the defect constitutes failure and requires subsequent removal or repair of the segment in question.

a. Conditions identified by the video inspection that require removal and replacement or, but are not limited to:
   1) Alignment (Vertical or Horizontal) is outside the specified limits.
   2) Water ponds in any section with depths equal to or greater than 2 times the grade tolerance specified in the Contract Documents.
   3) Pipe section with visible defects, such as: open joints, pinched gaskets, cracked barrels or bells, leaks, or other defects as determined by the Engineer.

3.4 TESTING OF MANHOLES AND OTHER APPURTENANT STRUCTURES

A. Manholes and other structures
   1. Vacuum tests shall be conducted on the newly constructed manholes. Preliminary manhole testing may take place following construction after all connections are made, and before backfilling. Test results derived from this test will allow time for necessary repairs to be completed before further construction proceeds and hinders such repairs. Final tests must be performed after the manhole has been backfilled.

B. Procedures
   1. Plug all manhole entrances and exits other than the manhole top access using suitably sized pneumatic or mechanical pipeline plugs and follow all manufacturer's recommendations and warnings for proper and safe installation of such plugs. Plugs should be inserted a minimum of 6 inches beyond manhole wall. Make sure such plugs are properly rated for the pressures required for the test. The standard test of 10 inches Hg. (mercury) is equivalent to approximately 5 PSIG (.3 bar) backpressure. Unless such plugs are mechanically restrained, it is recommended that the plugs are used with a minimum two times (2x) safety factor or a minimum of 10 PSIG (0.7 bar) backpressure usage rating.
   2. Close vacuum inlet/outlet ball valve and monitor vacuum for specified test period (see table). If vacuum does not drop in excess of 1" Hg., manhole is considered acceptable and the manhole passes the test. If manhole fails the test, complete necessary repairs and repeat test procedures until satisfactory results are obtained.

Minimum Test Times for Various Manhole Diameters													
Depth, Feet	Diameter, Inches												
	48	54	60	66	72	78	84	90	96	102	108	114	120
	Time, Seconds												
8	20	23	26	29	33	35	38	41	45	48	51	54	57
10	25	29	33	36	41	44	48	52	56	60	63	67	71
12	30	35	39	43	49	53	57	62	67	71	76	81	85
14	35	41	46	51	57	62	67	72	78	83	89	94	100
16	40	46	52	58	67	70	76	83	89	95	101	108	114
18	45	52	59	65	73	79	86	93	100	107	114	121	128
20	50	53	65	72	81	88	95	103	111	119	126	135	142
22	55	64	72	79	89	97	105	114	122	131	139	148	156
24	59	64	78	87	97	106	114	124	133	143	152	161	170
26	64	75	84	94	105	114	124	134	144	155	164	175	185
28	69	81	91	101	113	123	133	145	155	167	177	188	199
30	74	87	98	108	121	132	143	155	166	178	189	202	213

3. (The values listed above are taken from ASTM Specification C1244-93 “Standard Test Method for Concrete Manholes by the Negative Air Pressure (Vacuum) Test.”)
4. Repeat the above test procedure after backfilling manhole for final acceptance test.
5. Manholes shall be watertight. All joints, penetrations, etc., shall be sealed watertight prior to acceptance of manhole.

END OF SECTION

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SECTION 33 11 11
STEEL PIPE (AWWA C200, MODIFIED)

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide mortar-lined steel pipe coated as specified herein, complete, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards: The following standards are listed for convenience only. All specified standards, whether listed or not, shall apply to the Work.

ANSI/ASTM A 20	General Requirements for Steel Plates for Pressure Vessels
ASTM E 165	Practice for Liquid Penetrant Examination
ASTM A 370	Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A 516	Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ANSI/AWWA C200	Steel Water Pipe 6 In and Larger
ANSI/AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In and Larger - Shop Applied
ANSI/AWWA C206	Field Welding of Steel Water Pipe
ANSI/AWWA C207	Steel Pipe Flanges for Waterworks Service 4 in to 144 in
ANSI/AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
ANSI/AWWA C209	Cold Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
ANSI/AWWA C214	Tape Coating Systems for the Exterior of the Steel Water Pipelines
ANSI/AWWA C215	Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines
ANSI/AWWA C216	Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines

ANSI/AWWA C218	Coating the Exterior of Above Ground Steel Water Pipelines and Fittings
ANSI/AWWA C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
ANSI/AWWA C602	Cement-Mortar Lining of Water Pipelines 4-In (100 mm) and Larger - In Place
ANSI/ASTM A 36	Carbon Structural Steel
ANSI/ASTM A 283	Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A 570	Steel Sheet and Strip, Carbon, Hot-Rolled Structural Quality
ASTM A 572	High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM C 150	Portland Cement
ANSI/AWS D1.1	Structural Welding Code – Steel
API Standard 1104	Welding Pipelines and Related Structures
AWWA M-11	Steel Water Pipe - A Guide for Design and Installation
ASME	Boiler and Pressure Vessel Code

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings: Submit shop drawings of pipe and fittings in accordance with the requirements in Section 01 33 20 – Submittal Procedures, and the following supplemental requirements as applicable. Fittings and specials shall conform to Section 33 11 12 - Steel Pipe Fabricated Specials. Contractor's submittals for steel pipe and specials shall be coordinated between the sections.

B. Fabrication Information

a. Pipe/fitting wall construction details which indicate the type and thickness of cylinder; the position, type, size, and area of reinforcement; manufacturing tolerances; maximum angular joint deflection limitations; and all other pertinent information required for the manufacture and installation of the product.

b. Welded joint details shall be submitted for all joint types, including beveled ends for alignment conformance and deep bell or butt strap joints required for control of temperature stresses.

c. Rubber gasket joint design and details complete with dimensions, tolerances, and performance or test data.

d. Pipe Fabricator's Credentials: Submit the credentials of the pipe manufacturer/fabricator. Credentials shall include reference names, telephone numbers, and descriptions of projects for pipe conforming to

AWWA C200 that is of similar diameter, length, and wall thickness to the pipe in this project. Project description shall include length, diameter, wall thickness, steel metallurgy, location of facility where pipe was manufactured/fabricated, and names of key plant personnel responsible for the manufacturing process. Submit names and qualifications of current plant personnel to be responsible for manufacture of the pipe in this project.

e. Manufacturer's Written Quality Assurance/Control Program.

2. Materials: Material lists and steel reinforcement schedules which include and describe all materials to be utilized. Metallurgical test reports for steel proposed for use on the project. Submit chemical and physical test reports from each heat of steel that indicate the steel conforms to the Project Specifications.

3. Line Layout Information

   a. Line layout and marking diagrams compatible with the requirements of AWWA Manual 11 (M-11) and which indicate the specific mark number of each pipe and fitting and the location of each pipe and the direction of each fitting in the completed line. In addition, the line layouts shall include: the pipe station and centerline elevation at all changes in grade or horizontal alignment; the station and centerline elevation to which the bell end of each pipe will be laid; all elements of curves and bends, both in horizontal and vertical alignment. The location of all mitered pipe sections, beveled ends for alignment conformance, and deep bell or butt strap joints for temperature stress control shall be clearly indicated on the diagrams.

   b. Dimensional drawings of all valves, fittings, and appurtenances as specified in Section 40 05 00 – Piping, General.

   c. Drawings showing the location and details of bulkheads for hydrostatic testing of the pipeline, and details for removal of test bulkheads and repair of the lining.

   d. Details and locations of closures for length adjustment, temporary access manways, vents, and weld lead pass holes as indicated and as required for construction convenience.

4. Welding Information

   a. Information regarding location, type, size, and extent of all welds with reference called out for Welding Procedure Specifications (WPS) numbers shall be shown on the shop drawings. The shop drawings shall distinguish between shop and field welds. Shop drawings shall indicate by welding symbols or sketches the details of the welded joints, and the preparation of parent metal required to make them.

   b. Written welding procedures for shop and field welds, including Welding Procedure Specifications (WPS's) and Procedure Qualification Records (PQR's).

   c. Written nondestructive testing procedure specifications, and nondestructive testing personnel qualifications for shop and field welds.

   d. Current welder performance qualifications (WPQ's) shall be submitted for each welder used prior to its performing any Work either in the shop or field. Qualification testing shall be as specified in Article 1.4 - Quality Assurance, Paragraph F, in this Section.

   e. Submit the credentials of the Contractor's certified welding inspectors (CWI's) and quality control specialist for review prior to starting any welding

in the shop or field. The credentials shall include, but not be limited to, American Welding Society QC-1 Certification.

f. Submit all nondestructive testing (NDT) data for each shop-welded and field-welded joint. This data shall include all testing on each weld joint, including re-examination of repaired welds, using radiographic, magnetic particle, dye penetrant examination, ultrasonic, or air test examination methods specified. Test data shall be reviewed and signed by the welding inspector(s).

g. Submit a welder log for field and shop welding. Log shall list all welders to be used for the Work and the types of welds each welder is qualified to perform.

h. Submit a welding map showing the sequence of welds for all field welds.

i. Submit a written weld repair procedure for each type of shop and field weld proposed for use on the Project.

j. Submit a written rod control procedure for shop and field operations demonstrating how the Contractor intends to maintain rods in good condition throughout the Work. The rod control procedure shall also demonstrate how the Contractor intends to ensure that the proper rods are used for each weld.

5. Handling and Support Information: Detail drawings indicating the type, number and other pertinent details of the slings, strutting and other methods proposed for pipe support and handling during manufacturing, transport, and installation. Calculations supporting the handling and support system design shall be submitted. Drawings and calculations shall be sealed by a registered professional engineer.

6. Control of Temperature Stresses

   a. Submit proposed sequencing of events to control temperature stresses in the pipe wall during installation prior to starting of any field welding.

   b. Submit the proposed sequencing of events or special techniques to minimize distortion of the steel as may result from shop welding procedures.

   c. Submit plan for monitoring pipeline temperatures.

7. Field Lining

   a. Submit field lining contractor's credentials.

   b. Submit a description of lining equipment and personnel to be used.

   c. Submit written procedures for pipe surface preparation, lining application, and curing.

   d. Submit cement mortar mix design.

C. Certifications: Furnish a certified affidavit of compliance for all pipe and other products, materials, or related work provided under this Section, as specified in ANSI/AWWA C200, C205, C602, and C206, respectively, and the following supplemental requirements:

1. Compliance with the additional requirements included in these Contract Documents.
2. Physical and chemical properties of all steel.
3. Hydrostatic test reports.
4. Results of production weld tests.
5. Sand, cement, and mortar tests.
6. Rubber gasket tests.
7. All materials are NSF approved for use with potable water where applicable.
8. Pipe temperature complies with Specifications prior to pouring pipe zone material, during and between periods of CLSM placement, and prior to and during welding temperature control joints (including supporting data).
9. All welds were performed in conformance with these documents.

D. All expenses incurred in making samples or collecting data for certification of tests shall be borne by the Contractor at no increased cost to the Owner.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe, linings, welds, coatings, and related work shall be subject to inspection at the place of manufacture and/or the place the Work is performed in accordance with the provisions of ANSI/AWWA C200, C205, C206, C602, C209, C214, C215, and C222 as applicable, as supplemented by the requirements herein. Notify the Engineer in writing not less than 14 calendar days prior to the start of any phase of the pipe manufacture, welding, lining, coating, testing, or field operations.

B. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of ANSI/AWWA C200, C205, C206, and C602, as applicable.

1. After the joint configuration is completed and prior to lining with cement-mortar, if applicable, each length of pipe of each diameter and pressure class shall be shop-tested and certified to a pressure of at least 75 percent of the minimum yield strength of the pipe steel. Test pressure shall be maintained for a sufficient time to observe the weld seams. There shall be no leaks. Any leaks shall be repaired and the pipe retested.
2. Production weld tests as required in ANSI/AWWA C200, except weld tests shall be conducted on each 5,000 feet of production welds at a minimum, and at least one set of tests per operator per work shift shall be performed.

C. Perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.

D. In addition to those tests specifically required, the Engineer may request additional samples of any material including mixed concrete and lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

E. Welding Procedure Specifications: All welding procedures used to fabricate and install pipe shall be in accordance with the ASME Boiler and Pressure Vessel Code (BPVC) for shop welds and ANSI/AWS D1.1 for field welds. Written welding procedures shall be required for all welds, both shop and field. Welds qualified per the ASME BPVC shall include Supplementary Essential Variables for notch-tough welding. All provisions of ANSI/AWS D1.1 pertaining to notch-tough welding shall apply.

F. Welder Performance Qualifications: All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified by the Contractor under the provisions of ASME BPVC for shop welds and ANSI/AWS D1.1 for field welds. Furnish all material and bear the expense of qualifying welders.

G. Shop Nondestructive Testing: Nondestructive testing shall be performed for various weld categories as specified below. Testing shall include submitting written documentation of

procedures per Section V, and acceptance criteria shall be in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code.

1. Butt Joint Welds: Spot radiographically examine pipe in accordance with Paragraph UW-52 of the ASME Boiler and Pressure Vessel Code Section VIII, Division 1. If, in the opinion of the Engineer, the butt joint welds cannot readily be radiographed, they shall be 100 percent ultrasonically examined.
2. Fillet Welds: 100 percent examine all fillet welds using the magnetic particle inspection method.
3. Groove Welds: 100 percent ultrasonically examine all groove welds that cannot be readily radiographically spot examined.
4. All Welds: Certified welding inspector shall 100 percent visually examine all welds as a minimum.
5. In addition to weld tests hereinbefore specified, doubler pads shall be air tested as stated in AWWA C206.
6. Refer to Section 33 13 00 – Water Pipeline Testing and Disinfection for field nondestructive testing.

H. Onsite Observation: The pipe fabricator shall provide an experienced staff member to train the contractor's installation crews regarding pipe handling, jointing, and backfilling. Training shall be provided for a minimum of two weeks at the beginning of the project, and as needed during construction. The staff member's duties shall include, but not be limited to, the following:

1. Observe the installation and welding of the pipe and fittings.
2. Report any concerns to the Engineer's onsite observer.
3. Answer questions and provide assistance to the Engineer and the Contractor.

I. Certified Welding Inspector (CWI): Furnish the services of a certified welding inspector(s) for all shop and field welding as specified in AWWA C200 and C206. The certified welding inspector(s) shall 100 percent visually inspect all welds, verify proper procedures are being followed using qualified welders, supervise Contractor's non-destructive testing, and witness Engineer's non-destructive testing. The welding inspector(s) shall submit written certification that all welds were performed in conformance with these documents. All shop weld tests shall be reviewed and signed by the inspector(s).

J. Pipe Manufacturer/Fabricator: The manufacturer or fabricator of the pipe shall be experienced in fabricating pipe of similar diameters and wall thicknesses required for this Work and shall have the manufacturing capability to meet the schedule requirements of this project.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, steel pipe, linings and coatings shall conform to ANSI/AWWA C200, C205, C602, C209, C214, C215, C216, and C222, as applicable, subject to the following supplemental requirements. The pipe shall be of the diameter and wall thickness shown, shall be furnished complete with welded or gasket joints, as indicated in the Contract Documents, and all specials shall be provided as required in Section 33 11 12 - Steel

Pipe Fabricated Specials. For pipe larger than 24 inches in diameter, the inside diameter after lining shall not be less than the nominal diameter indicated unless otherwise shown. Pipe 24 inches in diameter and smaller may be provided in standard outside diameters.

B. Markings: Legibly mark all pipes and specials in accordance with the laying schedule and marking diagram. Each pipe shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. All special pipe sections and fittings shall be marked at each end with top field centerline. The word "top" shall be painted or marked on the outside top spigot of each pipe section.

C. Handling and Storage: The pipe shall be handled by use of wide slings, padded cradles, or other devices, designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment which might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be suitably supported and shall be secured to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials. Stockpiled pipe shall be supported on sand or earth berms free of rock exceeding 1 inch in diameter. The ends of all pipe shall be securely bulkheaded or otherwise sealed during transport to the jobsite. All pipe handling equipment and methods shall be acceptable to the Engineer.

D. Pay the cost of replacement or repair of pipe which is damaged at no increased cost to the Owner.

E. Strutting: Adequate strutting (stulling) shall be provided on all specials, fittings, and straight pipe so as to avoid damage or distortion to the pipe and fittings during handling, storage, hauling, and installation. The following requirements shall apply:
   1. The strutting shall be placed as soon as practicable after the pipe is fabricated or the mortar lining has been applied and shall remain in place while the pipe is loaded, transported, unloaded, installed and backfilled at the jobsite.
   2. The strutting materials, size and spacing shall be the responsibility of the Contractor and shall be adequate to prevent deflection and support the earth backfill plus any greater loads which may be imposed by the backfilling and compaction equipment. One strut shall be placed vertical oriented with the top of pipe. One set of struts shall be set 2 feet from each end of each pipe section and at a maximum interval of 15 feet in-between
   3. Any pipe damaged during handling, hauling, storage, or installation due to improper strutting shall be repaired or replaced.

F. Laying Lengths: Maximum pipe laying lengths shall not be limited unless specifically required by the Drawings. Contractor shall select lengths to accommodate the Contractor's operation.

G. Lining: The pipe lining shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing and roughness.

H. Cathodic Protection System: Cathodic protection systems shall be applied to pipelines as shown on the Drawings. Refer to Section 13 47 13 - Cathodic Protection System.

I. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing indicated. The locations of correction pieces and closure assemblies shall be shown on the pipe layout diagrams and shall be subject to the Engineer's review. Any change in location or number of said items shall be approved by the Engineer.

J. Shop-Welded Surfaces: All weld seams on pipe surfaces that will have a flexible tape coating in accordance with Section 09 97 01 - Pipeline Coatings and Linings shall be ground such that the maximum weld bead height will not exceed 1/32 inch. All ground weld seams shall be smooth and free of all burrs. Do not grind into, or gouge, the adjacent pipe wall material.

2.2 MATERIALS

A. Cement: Cement for mortar shall conform to the requirements of ANSI/AWWA C205; provided, that cement for mortar coating shall be Type V, and mortar lining shall be Type II or V, per ASTM C 150. Fly ash or pozzolan shall not be used as a cement replacement.

B. Steel: Provide steel coils for spiral welded steel pipe or steel plate for straight seam welded steel pipe per AWWA C200 and as follows:

1. Yield Strength: **42,000 psi** minimum. Measured yield strength shall not exceed 85% of measured tensile strength.
2. Minimum Tensile Strength**: 60,000 psi**
3. Coils: Steel coils shall be made from the continuous cast process or continuous cast slabs, fully killed, fine-grain practice conforming to the physical and chemical characteristics of ASTM A1018/A1018M, **SS Grade 45**. For sheet steel, the maximum allowable thickness variation shall be 0.010 inch under or over the nominal thickness.
4. Plate: Steel plate shall be fully killed, conform to ASTM A20, and be manufactured to fine-grain practice conforming to the physical and chemical characteristics of ASTM A572/A572M, **Grade 50**. For plate steel, the maximum allowable thickness variation shall be 0.010 inch under or over the nominal thickness.

C. Pipe shall be manufactured as fabricated pipe per AWWA C200 as modified herein. ASTM pipe manufacturing standards referenced in AWWA C200 shall not be used. Pipe sections shall be fabricated by either of the following methods:

1. Pipe sections may be spirally welded or fabricated from short cylindrical courses joined circumferentially by complete penetration butt joint welds with not more than two longitudinal seams per course. Longitudinal seams shall be staggered on both sides of the pipe.
2. Pipe sections may be rolled or pressed from no more than three sheets the full length of the pipe and welded with no more than three longitudinal seams. Patching inserts, overlays, or pounding out of dents will not be permitted. Repair of notches or laminations on second ends will not be permitted. Damaged ends shall be removed as a cylinder and the section end properly prepared. Distorted or flattened lengths shall be rejected. A buckled section shall be replaced as a cylinder.

D. Charpy Tests

1. General. Steel used in production manufacturing of pipe and specials shall be tested for notch toughness using Charpy V-Notch tests per ASTM A 370. The test acceptance shall be 25 foot-pounds at a test temperature of 30 degrees F.
2. Charpy V-Notch tests shall be conducted on all steel used in fabricating pipe and reinforcement materials 0.5-inch or greater in thickness. Test outside diameter wrap of two coils minimum per heat lot.
3. The Owner may elect to increase the Charpy testing to include more steel than indicated above at a negotiated price.

2.3 SPECIALS AND FITTINGS

A. Unless otherwise required, all specials and fittings shall be in accordance with Section 33 11 12 - Steel Pipe Fabricated Specials and shall conform to the dimensions of ANSI/AWWA C208.

2.4 DESIGN OF PIPE

A. General: The pipe and specials shall be steel pipe, **epoxy-lined and coated** as shown on the Drawings, with field welded joints or gasket as indicated. The pipe shall consist of a steel cylinder, with an exterior coating as indicated in Section 09 97 01 – Pipeline Coatings and Linings. Field lining will only be allowed where specifically indicated on the Drawings.

B. The pipe shall be manufactured, tested, inspected, and marked according to applicable requirements previously stated and except as hereinafter modified, shall conform to ANSI/AWWA C200.

C. Pipe Dimensions: The pipe shall be of the diameter and wall thickness shown on the Drawings. The minimum steel cylinder thickness for each pipe size shall be as indicated.

D. Specials Dimensions: The specials shall be of the diameter and wall thickness indicated on the Drawings, or as specified in Section 33 11 12 - Steel Pipe Fabricated Specials.

E. Joint Design: Unless otherwise shown on the Drawings, the standard field joint for steel pipe shall be **single-welded (fully circumferential)** lap joint. Mechanically coupled, or flanged joints shall be required where indicated on the Drawings. Butt-strap joints shall be used only where required for closures or where indicated. The joints furnished shall have the same or higher pressure rating as the abutting pipe. Provide air test tapped holes for each double welded lap joint as defined in Section 33 13 00 - Water Pipeline Testing and Disinfection.

F. Lap joints prepared for field welding shall be in accordance with ANSI/AWWA C200. The method used to form, shape and size bell ends shall be such that the physical properties of the steel are not substantially altered. Unless otherwise approved by the Engineer, bell ends shall be formed by an expanding press or by the pipe being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape. The ends shall not be rolled. Faying surfaces of the bell and spigot shall be essentially parallel, but in no case shall the bell slope vary more than 2 degrees from the longitudinal axis of the pipe.

G. Moderate deflections and long radius curves may be made by means of beveled joint rings, by pulling standard joints, by using short lengths of pipe, or a combination of these methods; provided that pulled joints shall not be used in combination with bevels and maximum joint

deflections are not exceeded. The maximum total allowable angle for beveled joints shall be 5 degrees per pipe joint. Bevels shall be provided on the bell ends. Mitering of the spigot ends will not be permitted. The maximum allowable angle for pulled joints shall be 75 percent of the manufacturer's recommendations or the angle which results from a ¾-inch pull out from normal joint closure, whichever is less. In no case shall pulled joints result in a gap between the bell and spigot at the weld location that exceeds 1/8 inch. All horizontal deflections or fabricated angles shall fall on the alignment, as shown.

H. All vertical deflections shall fall on the alignment within laying tolerance as described in Section 3.1.

I. Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe as indicated or as otherwise acceptable to the Engineer. Holdback areas shall be coated as hereinafter specified.

J. Temperature Control Lap Joint: A special longer bell end (temperature control lap joint) shall be provided at a maximum spacing of 400 feet to account for movement of the installed pipe due to temperature changes. The pipe manufacturer shall determine the length required for the longer bell as defined by the Contractor's pipe laying procedures and the location of the special bell. Minimum temperature control lap joint length shall be as shown on the Drawings.

K. Joint Shop Coating: All holdback areas for welded joints, all butt straps, and all bell and spigot joint rings for rubber-gasketed joints shall be thoroughly cleaned and given a shop coat of rust-inhibitive primer. The surface preparation and primer shall be compatible with the intended finish coating as specified in Section 09 90 01 – Protective Coatings, Section 09 97 01 – Pipeline Coatings and Linings, as applicable.

L. Shop Fit Test (NOT USED)

M. The pipe ends shall be match marked after shop assembly.

2.5 CEMENT-MORTAR LINING

A. Cement-Mortar Lining for Shop Application: Where indicated on the Drawings, interior surfaces of all steel pipe, fittings, and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C205. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work and shall be approved by the Engineer. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at the delivery site, or after installation, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications at no additional cost to the Owner.

B. The minimum lining thickness shall be in accordance with Section 09 90 01 Pipeline Coatings and Lining.

C. The pipe shall be left bare where field joints occur as indicated. Ends of the linings shall be left square and uniform. Feathered or uneven edges will not be permitted.

D. Defective linings, as determined by the Engineer, shall be removed from the pipe wall and shall be replaced to the full thickness required. Defective linings shall be cut back to a square shoulder in order to avoid feather edged joints. Temperature and shrinkage cracks in the mortar less than 1/16 inch wide need not be repaired. Pipe, specials, or fittings with cracks wider than 1/16 inch shall be rejected or repaired per C205 at the discretion of the Engineer.

E. The progress of the application of mortar lining shall be regulated in order that all hand work, including the repair of defective areas is cured in accordance with the provisions of ANSI/AWWA C205. Cement-mortar for patching shall be the same materials as the mortar for shop or machine lining, except that a finer grading of sand and mortar richer in cement shall be used when field inspection indicates that such mix will improve the finished lining of the pipe.

F. Cement-Mortar Lining: Unless otherwise indicated, all steel pipe shall be mortar-lined. The materials and design of in-place cement-mortar lining shall be in accordance with ANSI/AWWA C602 and the following supplementary requirements:

1. Pozzolanic material shall not be used in the mortar mix.
2. Admixtures shall contain no calcium chloride.
3. The minimum lining thickness shall be as indicated for shop-applied cement-mortar lining and finished inside diameter after lining shall be as indicated.
4. Temperature and shrinkage cracks in the mortar less than 1/16 inch wide need not be repaired. Pipe, specials, or fittings with mortar cracks wider than 1/16 inch shall be rejected or repaired at the discretion of the Engineer.
5. Field applied mortar lining shall meet the requirements of this Subparagraph F.
6. Grout mixture for field applied joint lining shall include two parts sand to one part Type II Portland Cement by volume and potable water. NSF approved acrylic latex admixture (Flex-Con, or equal) shall be added to mortar as needed to make dough like consistency for hand packing into joint area.

G. Protection of Pipe Lining/Interior: For all pipe and fittings with plant-applied cement-mortar linings, provide a polyethylene or other suitable bulkhead on the ends of the pipe and on all special openings to prevent drying out of the lining. All bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.

2.6 EXTERIOR COATING OF PIPE

A. Exterior Coating of Steel Pipe: The exterior coating of all steel pipe shall be in accordance with Section 09 97 01 – Pipeline Coatings and Linings.

2.7 PIPE APPURTENANCES

A. Pipe appurtenances shall be in accordance with the requirements of Section 40 05 00 - Piping, General.

2.8 PIPELINE MARKING TAPE

A. Metallic tape: Terra Tape Sentry Line Detectable manufactured by Reef Industries, Inc., 9209 Alemeda Genoa Road, Houston, TX 77075, www.reefindustries.com; or approved equal, having the following essential characteristics:

a. Aluminum foil encased in high visibility inert polyethylene jacket.
b. Total thickness: 6.0 mils, minimum.
c. Core foil thickness: 0.30 mils, minimum.
d. Width: 6 inches, minimum.
e. Imprinted on one side, 1-inch-tall, permanent black lettering.
f. Color: as listed below.
g. Joining clips shall be manufacturer's standard tin or nickel coated.
h. Tape shall read for example "JVWCD-Buried Pipeline Below".

B. Plastic tape: Terra Tape Extra Stretch manufactured by Reef Industries, Inc., 9209 Alemeda Genoa Road, Houston, TX 77075, www.reefindustries.com; or equal, having the following essential characteristics:
a. Polyolefin or similar chemically inert material unsusceptible to alkalies, acids, and chemicals and solvents likely in the soil.
b. Thickness: 8.0 mil, minimum.
c. Width: 12 inches minimum.
d. Color: as listed in below.
e. Imprinted on one side, 1-inch-tall, permanent black lettering on a colored background.
f. Tape shall read for example "**[JVWCD]-**Buried Pipeline Below".

2.9 MARKERS

A. Provide pipeline markers at the locations indicated. Markers in open areas shall be High Visibility Tri-View Utility Marking Posts as manufactured by Rhino Marking and Protection Systems (www.rhinomarkers.com). Coordinate color and lettering with Owner prior to installation. Markers shall be provided at the following locations:
1. Both sides of street and canal crossings.
2. At locations of cathodic protection test stations (see test station table).
3. At the beginning and end of open areas and at a maximum interval of 500-ft.

B. Brass Caps: Caps shall be 2-1/2-inch diameter brass caps with posts set by epoxy into holes drilled into the curb adjacent to the pipeline. Brass caps and monuments shall be provided in locations as described in the plans. Caps shall be stamped as shown on the details and shall be provided at the following locations:
1. Fittings or elbows.
2. Both sides of street and canal crossings.
3. Within deck of concrete structures (manholes, vaults, etc.)

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE

A. Handling and Storage: All pipe, fittings, and specials shall be carefully handled and protected against damage to lining and coating/interior and exterior surfaces, impact shocks, and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground but shall be supported in a manner which will protect the pipe against injury whenever stored at the trench site or elsewhere. Pipe shall be handled and

stored at the trench site in accordance with the requirements stated below. No pipe shall be installed when the lining or coating/interior or exterior surfaces show cracks or other damage that may be harmful as determined by the Engineer. Such damaged lining and coating/interior and exterior surfaces, shall be repaired to the satisfaction of the Engineer, or a new undamaged pipe shall be furnished.

B. All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor at no additional cost to the Owner.

C. Inspect each pipe and fitting to insure that there are no damaged portions of the pipe. Remove or smooth out any burrs, gouges, weld splatter or other small defects prior to laying the pipe.

D. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance, which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the Work.

E. Lifting points shall be no closer than the 1/3 and 2/3 points along the length of the Section. Contractor shall be responsible for selecting lifting points that when used, do not result in damage to the pipe.

F. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

G. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints, short lengths of pipe, by the use of beveled joint rings, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed 75 percent of the maximum deflection recommended by the pipe manufacturer or the amount that results in more than a 1/8-inch gap at the weld location, whichever is less. No joint shall be misfit any amount which will be detrimental to the strength and water tightness of the finished joint.

H. Except for short runs which may be permitted by the Engineer, pipes shall be laid uphill on grades exceeding 10 percent. Pipe which is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. All bends shall be properly installed as shown.

I. Pipe struts shall be left in place until backfilling operations have been completed for pipe 42 inches in diameter and larger. Struts in pipe smaller than 42 inches may be removed immediately after laying, provided, that the deflection of the pipe during and after backfilling does not exceed that specified. After the backfill has been placed to a minimum of 3-feet, the struts shall be removed by the Contractor and shall remain the property of the Contractor. Struts shall not be removed with a torch or any other method that may damage the pipe lining or coating. The parent pipe material shall not be nicked, gouged, or damaged during strut removal. All repairs of gouges or nicks in the parent material shall be made using 3/32-inch

maximum diameter E-6010 welding electrodes with a maximum heat input of 5.6 kj per inch. Tack welds, stull metal, weld splatter, slag, and burrs that remain attached to the parent metal surface after cutting shall be ground to within 1/32 inch of the parent metal. Grinding shall not penetrate the parent metal. The Contractor shall notify the Engineer prior to grinding. Following grinding, all pipe surfaces at the tack weld shall be visually inspected for defects. All defects deeper than 1/16 inch shall be repaired by welding in accordance with ANSI/AWSD.1.1 and AWWA/ANSI C206. All inspection work shall be performed by a certified welding inspector.

J. For pipe backfilled with CLSM, the pipe shall be laid directly on moist sandbags or other suitable supports approved by the Engineer in preparation for CLSM pipe zone material. Sandbags shall be placed to provide at least 6 inches of CLSM below the bottom of the pipe. Sandbags shall be spaced at a maximum interval of 8 feet and one set shall be placed within 3 feet on both sides of each joint. The Contractor shall provide additional sandbags as needed to support the pipe on line and grade. For pipe bedded in granular material, no blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

K. At all times, means shall be provided to prevent the pipe from floating. Take all necessary precautions to prevent the pipe from floating due to water entering the trench or from backfilling with CLSM. The Contractor shall assume full responsibility for any damage due to this cause and shall at its own expense restore and replace the pipe to its specified condition and grade if it is displaced due to floating. Maintain the inside of the pipe free from foreign materials and in a clean and sanitary condition until its acceptance by the Owner.

L. Bulkheads
   1. Prior to shipment of pipe with cement mortar lining the lining shall be wetted then a suitable bulkhead shall be attached to each end of the pipe section. This bulkhead shall remain in place and in good condition through transit to the Project.
   2. During construction the openings of all pipe and specials where the pipe and specials have been cement-mortar lined in the shop shall be protected with suitable bulkheads to maintain a moist atmosphere and to prevent unauthorized access by persons, animals, water or any undesirable substance. The bulkheads shall be so designed to prevent drying out of the interior of the pipe. Introduce water into the pipe as needed to keep the mortar moist where moisture has been lost due to damaged bulkheads.

M. Pipe Cleanup: As pipe laying progresses, keep the pipe interior free of all debris. Completely clean the interior of the pipe of all sand, dirt, mortar splatter and any other debris following completion of pipe laying and any necessary interior repairs prior to testing and disinfecting the completed pipeline.

N. Installation Tolerances: Each section of pipe shall be laid in the order and position shown on the laying diagram and the following requirements:

1. Each section of pipe having a nominal diameter less than 48 inches shall be laid to line and grade, within plus or minus 2 inches horizontal deviation and plus or minus 1 inch vertical deviation.
2. Each section of pipe having nominal diameter 48 inches and larger shall be laid to line and grade, within plus or minus 5 percent of diameter horizontal deviation and plus or minus 2.5 percent of diameter vertical deviation.
3. In addition to the horizontal and vertical tolerances above, lay the pipe so that no high or low points other than those on the laying diagram are introduced.
4. Pipe deflection, after backfill but prior to installation of field-applied cement mortar lining, if applied, shall not exceed 2.25 percent for flexible coated pipe and 1.5 percent for cement mortar coated pipe. Deflection shall be measured by the difference in vertical inside diameter in the installed pipe and the manufactured pipe.
5. Pipe not conforming to these criteria or which otherwise impact the ability to complete the Work shall be removed and reinstalled in full conformance with the Contract Documents at no additional cost to the Owner.
6. For each section of pipe, record the invert elevation at the lower end and incorporate the data on the Record Drawings.

O. Protection of Pipe: At locations where the Contractor proposes to cross the installed pipeline with heavy equipment, precautions as approved by the Engineer shall be taken to protect the pipe from damage. Acceptable precautions include: backfilling the pipe trench as necessary to protect the pipe, concrete encasing the pipe, and placing steel plating over the pipe. Any damage to the pipe caused by the Contractor's operation or his equipment shall be repaired at no additional cost to the Owner.

3.2 WELDED JOINTS

A. Welding Procedures, Welding Qualifications, and Testing
1. Field welding procedures, welders, welding operators, and tackers shall be qualified in accordance with AWS D1.1 and as defined in Section 3 of ANSI/AWWA C206 or ANSI/AWWA C200, as applicable. All qualifications shall be in accordance with all-position pipe tests as defined in Section 5 of AWS D1.1.
2. For field welding, the welder qualification testing shall be performed at the site. Previous qualifications will not be accepted. The Contractor shall obtain the services of an independent testing laboratory to perform the welder qualification onsite. Copies of all test data and certifications shall be provided to the Engineer. All costs for welder qualification testing shall be at no increased cost to the Owner.
3. Upon completion of each field-welded joint, the welding operator shall mark his regularly assigned identification number and the last two numbers of the year in which the Work was completed, or the Contractor may have a records system that traces a welder's work completion to a specific joint. Steel stamping directly on piping will not be permitted unless "low stress" die stamps, such as interrupted dot or round nose types, are used.
4. All single welded lap joints will be inspected by the CONTRACTOR in the presence of the Engineer using magnetic particle or dye penetration methods. Field butt welds will be inspected by the CONTRACTOR in accordance with the requirements of API 1104 by the radiographic method and the acceptance criteria of API 1104. Magnetic particle testing is not required for seal welds.

5. All double welded lap joints and butt strap joints shall be air tested by the CONTRACTOR in the presence of the Engineer in accordance with Section 33 13 00 - Water Pipeline Testing and Disinfection. Repairs and retesting shall be required if any loss of pressure occurs.
6. The Contractor shall inform the Engineer before completed weld joints are to be backfilled so that the joint may be inspected. The Contractor shall assume all costs of exposing backfilled joints for inspection when backfilling preceded the inspection.
7. Personnel performing visual inspection of welds shall be qualified and currently certified as Certified Welding Inspectors (CWI) in accordance with AWS QC1, Standard for Qualification and Certification of Welding Inspectors. Personnel performing nondestructive tests shall be qualified and certified to the requirements of SNT-TC-1A.
    a. The Engineer may also order nondestructive testing by an independent testing laboratory in addition to any testing specified herein. Except as otherwise specified herein, all costs for the independent testing laboratory to inspect and test field welds will be paid for by the Owner. If the weld is defective, the inspection costs shall be paid for by the Contractor. Defective welds shall be repaired and retested at the Contractor's expense.
    b. Test reports of all laboratory tests shall be submitted as provided in the quality control section.

B. Where exterior welds are performed, adequate space shall be provided for welding and inspection of the joints.

C. Lap Welded Joints: During installation of welded steel pipe in either straight alignment or on curves, the pipe shall be laid so that at any point around the circumference of the joint there is a minimum lap as shown on the Drawings.

D. Butt Straps: Where used or required, shall be as shown on the Drawings.

E. After the pipe and pipe joint are properly positioned in the trench, weld and provide external joint protection for all joints except the special temperature control lap joint hereinafter specified. The length of pipe between special temperature control joints shall be backfilled to at least one foot above the top of the pipe as hereinafter specified. The special temperature control joints shall be welded after the pipe is backfilled to at least one foot above the top of the pipe for the full distance between the temperature control joints upstream and downstream. Joint protection shall be provided for special temperature control joints after completion of the joint welds and tests as specified. Care shall be exercised during the initial backfilling to prevent movement of the pipe and to prevent any backfill material from being deposited on the special temperature control joint.

F. Control of Temperature Stresses
1. Control temperature stresses in accordance with AWWA C206, the approved temperature stress control submittal, and these Specifications. Provide special temperature control lap joints at intervals of 400 feet or less, unless otherwise approved by the Engineer.
2. To control temperature stresses, the unbackfilled special temperature control joint areas of all pipe shall be shaded from the direct rays of the sun by the use of properly supported awnings, umbrellas, tarpaulins, or other suitable materials until the pipe

is backfilled at least 1 foot over the top of the pipe. The "temperature control joint area" is defined as the entire length of pipe left exposed near a control joint after placing the pipe backfill between it and the other control joints in each direction. The term "special temperature control joint area" is defined as the entire length of pipe left exposed near a control joint after placing the backfill between it and the other control joints in each direction. Shading materials at the joint area shall not rest directly on the pipe but shall be supported to allow air circulation around the pipe. Shading of the pipe joints need not be performed when the ambient air temperature is below 45 degrees F.

3. At intervals not exceeding 400 feet along welded reaches of the pipeline, at the first regular lap-welded field joints outside concrete encasements and structures, and where shown, the pipe shall be supplied with a special temperature control lap joint and laid with an initial lap of not less than 3 inches greater than the typical lap joint. Where temperature control lap joints occur in a traveled roadway or other inconvenient location, the location of the joint may be adjusted, as acceptable to the Engineer.

4. Provide and install thermocouple temperature gauges to monitor the temperature of the steel pipe wall on the inside top of the pipe as it lays in the trench. All pipe temperature requirements specified herein shall be measured at the top inside of the steel cylinder. Specific temperature requirements for the pipeline steel cylinder shall be met prior to installation of the controlled low strength material (CLSM), during and after placement of CLSM, and during welding of the special temperature control joints. If atmospheric conditions do not allow the conditions to be met, supplemental cooling shall be required by the Contractor. The following outlines the specific temperature control requirements.

   a. Prior to and during placement of the CLSM, the pipeline steel temperature shall be at or below 90 degrees F. The specified temperature shall be maintained for at least three hours after the placement of CLSM. The specified temperature shall be maintained until the line is fully backfilled. Provide supplemental cooling as required.

   b. Placement of CLSM shall proceed in the direction of pipe laying from one special temperature control joint to the next. During placement of CLSM, the lead end of the pipe section (toward the next special temperature control joint) shall be left unbackfilled or otherwise unrestrained such that the end of the pipe is free to move in response to expansion or contraction due to temperature changes. CLSM shall not be placed in a direction which would result in CLSM placement proceeding in a direction toward previously or simultaneously placed CLSM without the written permission of the Engineer. The direction of CLSM placement will not be limited for placement at the short unbackfilled section immediately adjacent to the special temperature control joints.

   c. During periods between CLSM placement operations, any section of pipeline that is backfilled with CLSM shall be shaded from the direct rays of the sun by the use of properly supported awnings, umbrellas, tarpaulins, or other suitable materials until the pipe is backfilled at least 1 foot over the top of the pipe. The temperature of the partially backfilled pipe shall not be allowed to exceed 110 degrees Fahrenheit at any time. Provide supplemental cooling as required. Shading materials shall not rest directly on the pipe but shall be supported to allow air circulation around the pipe. Shading of the partially

backfilled pipe need not be performed when the Contractor can demonstrate to the satisfaction of the Engineer, using thermocouple data, that shading is not necessary to the Contractor to meet the specified temperature requirement.

d. Prior to welding the special temperature control joints, the pipeline extending 400 feet each direction from the joint shall be maintained at or below 85 degrees F. Additionally, the pipeline extending 400 feet each direction from the joint shall be backfilled with CLSM to at least one foot over the top of the pipe. At the specified temperature, the special temperature control joints can be welded. Begin and complete the weld during the coolest interval of suitable length within a 24-hour day. Use the thermocouple temperature data to demonstrate to the Engineer the coolest interval of the day.

e. After welding any temperature control joint, the pipe temperature for 150 feet in each direction from the control joint shall be maintained below 110 degrees F for a minimum of 24 hours after the temperature control joint area has been backfilled to at least 1 foot over the top of the pipe. This requirement is in addition to the shading and CLSM placement temperature requirements indicated herein.

G. Prior to the beginning of pouring CLSM or beginning the welding procedure, any tack welds or joint stops used to position the pipe during laying shall be removed. Any annular space between the faying surfaces of the bell and spigot shall be equally distributed around the circumference of the joint by shimming, jacking, or other suitable means. The weld shall then be made in accordance with ANSI/AWWA C206. Where more than one pass is required, all dirt, slag, and flux shall be removed before the succeeding bead is applied.

H. Testing of Joints: The pipeline joints shall be tested as specified herein and in Section 33 13 00 - Water Pipeline Testing and Disinfection.

I. Following tests of the joint, the exterior joint spaces shall be coated in accordance with these Specifications after which backfilling may be completed.

J. Joints: The pipe ends shall be cut straight on joints where butt straps are used for realignment, adjustment, or deflection, and fillet welds shall be made as indicated.

K. Repair of Welds: All welds that are defective shall be repaired by the Contractor to meet the requirements of this Section at no additional cost to the Owner. Defects in welds or defective welds shall be removed, and that section of the joint shall then be rewelded. Only sufficient removal of defective material that is necessary to correct the defect is required. After the repair is made, the joint shall be checked by repeating the original test procedure. Welds deficient in size shall be repaired by adding weld metal.

3.3 JOINT COATING AND LINING

A. General: The interior and exterior joint recesses shall be thoroughly wiped clean and all water, loose scale, dirt and other foreign material shall be removed from the inside surface of the pipe.

B. Joint Coating: In accordance with the requirements of Section 09 97 01 – Pipeline Coatings and Linings.

C. Joint Lining:
   1. Clean joint to remove dirt, debris, and other contaminants.
   2. Hand apply coating/lining according to Section 09 97 01 – Pipeline Coatings and Linings.

3.4 CEMENT-MORTAR LINING, FIELD-APPLIED (NOT USED)

3.5 INSTALLATION OF PIPE APPURTENANCES

A. Protection of Appurtenances: Where the joining pipe is concrete or coated with cement mortar, buried appurtenances shall be coated with a minimum thickness of one inch of cement mortar having one part cement to not more than two parts plaster sand. Following coating with cement mortar, the appurtenances shall be coated with a protective overcoat in accordance with the paragraph entitled "Protective Coating."

B. Installation of Valves: All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. Adjust all stem packing and operate each valve prior to installation to insure proper operation. Valves (body and seat) shall not be subjected to test pressures greater than manufacturer's recommendation. In some cases this may require an increase in the valve pressure class.

C. All buried valves shall be coated and protected in accordance with Section 09 97 01 - Pipeline Coatings and Linings.

D. All valves shall be installed so that the valve stems are plumb and in the location indicated.

E. Installation of Flanged Joints: Before the joint is assembled, the flange faces shall be thoroughly cleaned of all foreign material with a power wire brush. The gasket shall be centered and the connecting flanges drawn up watertight without unnecessarily stressing the flanges. All bolts shall be tightened in a progressive diametrically opposite sequence and torqued with a suitable, approved and calibrated torque wrench. All clamping torque shall be applied to the nuts only.

F. All buried flanges shall be coated and protected in accordance with Section 09 97 01 - Pipeline Coatings and Linings.

G. Flexible Coupled Joints: When installing flexible couplings, care shall be taken that the connecting pipe ends, couplings and gaskets are clean and free of all dirt and foreign matter with special attention being given to the contact surfaces of the pipe, gaskets and couplings. The couplings shall be assembled and installed in conformity with the recommendation and instruction of the coupling manufacturer.

H. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer. Coupling bolts shall be tightened so as to secure a uniform annular space between the follower rings and the body of the pipe with all bolts tightened approximately the same amount. Diametrically opposite bolts shall be tightened progressively and evenly.

Final tightening shall be done with a suitable, approved and calibrated torque wrench set for the torque recommended by the coupling manufacturer. All clamping torque shall be applied to the nut only.

I. Upon completion of the coupled joint, the coupling and bare metal of the pipe shall be cleaned, primed and protected in accordance with the requirements of Section 09 97 01 - Pipeline Coatings and Linings.

3.6 CORROSION CONTROL

A. Cathodic Protection: Corrosion mitigation and testing materials shall be provided where indicated and in accordance with Section 13 47 13 - Cathodic Protection.

3.7 MARKING TAPE INSTALLATION

A. As shown on the Drawings.

3.8 PIPELINE TESTING

A. The steel pipe shall be hydrostatically tested as specified in Section 33 13 00 – Water Pipeline Testing and Disinfection.

END OF SECTION

SECTION 33 11 12
STEEL PIPE FABRICATED SPECIALS (AWWA C200, MODIFIED)

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide all bends, reducers, wyes, tees, crosses, outlets, manifolds and other steel plate specials, complete in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ASME B 16.9	Factory-Made Wrought Steel Butt Welding Fittings
ASTM E 165	Practice for Liquid Penetrant Examination
ANSI/AWWA C200	Steel Water Pipe 6 In and Larger
ANSI/AWWA C205	Cement Mortar Lining and Coating – Shop Applied
ANSI/AWWA C206	Field Welding of Steel Water Pipe
ANSI/AWWA C207	Steel Pipe Flanges for Waterworks
ANSI/AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
ANSI/AWWA C602	Cement-Mortar Lining of Water Pipelines - 4 In (100 mm) and Larger - In Place
ASTM A234	Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ANSI/AWS D.1.1	Structural Welding Code - Steel
API Standard 1104	Welding Pipelines and Related Structures
AWWA M-11	Steel Water Pipe - A Guide for Design and Installation
ASME	Boiler and Pressure Vessel Code

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings: Submit shop drawings including line and layout diagrams of all steel pipe fabricated specials in accordance with the requirements in Section 01 33 20 – Submittal Procedures. All submittals required for steel pipe and related work as listed in Section 33 11 11 - Steel Pipe, shall also be required for specials. Shop drawings shall indicate the type, size, and location of all reinforcement pieces.

B. Design calculations shall be submitted to the Engineer for review prior to manufacture of steel pipe fabricated specials.

C. Certifications: A certified affidavit of compliance with referenced Specifications and these Contract Documents shall be furnished for all steel pipe fabricated specials and other products or materials provided under this Section.

1.4 QUALITY ASSURANCE

A. Inspection: All specials shall be subject to inspection at the place of manufacturer/ fabrication as outlined in Section 33 11 11 - Steel Pipe.

B. Shop Testing of Steel Pipe Fabricated Specials:
   1. If steel pipe fabricated specials have been fabricated from untested straight pipe, they shall be hydrostatically tested with a pressure equal to 1-1/2 times the design working pressure shown on the Drawings. If steel pipe fabricated specials have been fabricated from successfully tested straight pipe, no hydrostatic test shall be required unless otherwise indicated. In no case shall shop test pressure be less than 150 psi. All tees with crotch plates shall be hydrostatically tested as indicated regardless of whether or not the straight pipe sections used were previously tested.
   2. All welds shall be non-destructive tested at the specials fabricator's facility as specified below for various weld categories. Testing shall include submitting written documentation of procedures per Section V, and acceptance criteria shall be in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code.
      a. Butt Joint Welds: Spot radiographically examine pipe in accordance with paragraph UW-52 of the ASME Boiler and Pressure Vessel Code Section VIII, Division 1. If, in the opinion of the Engineer, the welds cannot readily be radiographed, they shall be 100 percent ultrasonically examined.
      b. Fillet Welds: 100 percent examine all fillet welds using the magnetic particle inspection method.
      c. Groove Welds: 100 percent ultrasonically examine all groove welds that cannot be readily radiographically spot examined.
      d. Welds on pipe seams for previously successfully tested straight pipe do not need to be retested.
      e. All Welds: Contractor's certified welding inspector shall 100 percent visually examine all welds as a minimum.
      f. In addition to weld tests herein before specified, doubler pads shall be air tested as stated in AWWA C206.
      g. Refer to Section 33 13 00 - Water Pipeline Testing and Disinfection for field non-destructive testing.
   3. Where welded test heads or bulkheads are used, extra length shall be provided to each opening of the special. After removal of each test head, the special shall be trimmed back to the design points with all finished plate edges ground smooth, straight, recoated and prepared for the field joint.
   4. Testing shall be performed before pipe and joints have been coated or lined.
   5. Perform tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor, provided that the Contractor's schedule is not delayed for the convenience of the Engineer.

6. In addition to those tests specifically required, the Engineer may request additional samples of any material including mixed concrete and lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

C. Field Testing: Field testing shall conform to the requirements of Section 33 13 00 - Water Pipeline Testing and Disinfection.

D. Welding Procedure Specifications: All welding procedures used to fabricate pipe shall be in accordance with Section 33 11 11 - Steel Pipe.

E. Welder Performance Qualifications: All welder performance qualifications shall be in accordance with Section 33 11 11 - Steel Pipe.

F. Certified Welding Inspector: A certified welding inspector shall be provided for shop fabricated work and shall have the responsibilities outlined in Section 33 11 11 - Steel Pipe.

G. Fittings and Specials Fabricator:
1. Experienced in fabrication of fittings and specials of similar diameters and wall thickness required for the Work.
2. Demonstrate current production capability for volume of Work required for the Project.
3. Experience shall be for project requiring fabrication to AWWA C200/208 standards of at least 25 fittings **24-inch** or larger pipe, with wall thickness 0.375-inch or larger within the 5-year period preceding the bid date.
4. Experience requirement shall apply to the fabrication plant facility and responsible personnel, not the firm which owns the facility or employs the personnel.
5. See Section 33 11 11 – Steel Pipe for qualifications for steel pipe fabricators.

H. Fabrication: All specials shall be fabricated in the shop. No field fabrication of specials will be allowed.

PART 2 - PRODUCTS

2.1 GENERAL

A. Steel pipe fabricated specials (specials) are defined as fittings, closure pieces, bends, elbows, reducers, wyes, tees, crosses, outlets, manifolds, steel pipe wall sleeves, and other steel plate specials wherever located, and all piping above ground or in structures.

2.2 DESIGN

A. Design: Except as otherwise provided herein, specials shall be fabricated from materials or straight pipe in full conformance with the requirements of Section 33 11 11 - Steel Pipe, ANSI/AWWA C200, and the dimensions of ANSI/AWWA C208. All fittings and specials shall be properly reinforced to withstand the internal pressure, with circumferential and longitudinal, or external loading conditions, whichever is greater. The minimum thickness of plate for pipe from which specials are to be fabricated shall be no less than the thickness of the adjacent mainline pipe, the thickness shown, or the following, whichever is thicker:

Nominal Pipe Diameter (in)	Pipe Manifolds, Piping Above Ground, and Piping in Structures	Elbows, Bends, and Reducers
30 and under	Standard Weight	Standard Weight
Over 30	3/8-inch	Same as Adjacent Pipe

B. Pipe installed on saddle supports shall be designed to limit the longitudinal bending stress to a maximum of 10,000 psi. Design shall be in accordance with the provisions of Chapter 7 of AWWA M-11, and other applicable industry standards.

C. Joints: All joints and related work for field assembly of the pipe and specials shall conform to Section 33 11 11 - Steel Pipe. All shop joints shall be complete penetration butt-welds unless otherwise shown.

2.3 FABRICATION AND MATERIALS

A. General: Reinforcement for wyes, tees, outlets, and nozzles shall be as shown. Shop welding shall conform to the applicable provisions of the ASME Boiler and Pressure Vessel Code. Field welding shall conform to ANSI/AWS D1.1 and ANSI/AWWA C206. Specials and fittings shall be equal in pressure design strength and shall have the same lining and coating as the adjoining pipe. Unless otherwise indicated, the minimum radius of elbows shall be 2.5 times the pipe diameter and the maximum miter angle on each section of the elbow shall not exceed 11-1/4 degrees resulting in a maximum deflection angle of 22.5 degrees per miter weld as recommended in AWWA C208.

B. Specials and fittings that cannot be mechanically lined and coated shall be lined and coated by hand-application, using the same materials as are used for the pipe and in accordance with the applicable AWWA or ASTM Standards, and as modified in Section 09 97 01 - Pipeline Coatings and Linings, or by other applicable sections in these Specifications. Coating and lining applied in this manner shall provide thickness and protection equal to that specified for the pipe. Fittings may be fabricated from pipe that has been mechanically lined and/or coated. Areas of lining and coating that have been damaged by such fabrication shall be removed and reapplied by hand-applications.

C. Access manholes with covers shall be as indicated. All threaded outlets shall be forged steel suitable for 3,000-psi service, and shall be as manufactured by Vogt or equal.

D. Outlets, Tees, Wyes, and Crosses
   1. Outlets 14-inch and smaller shall be fabricated from ASTM A 53, Type E or S, Grade B, standard weight steel pipe in the standard outside diameters, i.e., 14, 12-3/4-inch, 10-3/4-inch, 8-5/8-inch, 6-5/8-inch, and 4-1/2-inch. Wall thickness and collar reinforcing shall be as shown.
   2. In lieu of collar reinforcement as shown, pipe or specials with outlets may be fabricated in their entirety of steel plate having a thickness equal to the sum of the pipe wall plus the required reinforcement.
   3. Where required by Manual M-11 or other industry standard, the design procedure for crotch plate reinforcement, such reinforcement shall be required.

E. Steel Welding Fittings: Steel welding fittings for pipe spools and fittings smaller than 24 inches in diameter shall be in accordance with ANSI B16.9 conforming to ASTM A 234. Use standard weight. Taper pipe wall at welds at 4:1 for connection to pipe of different wall thicknesses. The Contractor shall be fully responsible for coordinating the difference in diameter convention between these specials and AWWA C200/C208 pipe and fittings to provide complete piping systems as shown.

F. Ends for Mechanical-Type Couplings: Except as otherwise indicated, where mechanical-type couplings are indicated, the ends of pipe shall be banded with Type C collared ends using double fillet welds. Where pipe 12-inch and smaller is furnished in standard schedule thicknesses, and where the wall thickness equals or exceeds the coupling manufacturer's minimum wall thickness, the pipe ends may be grooved.

G. Lining: All requirements pertaining to thickness, application and curing of lining indicated for straight pipe shall apply to specials, with the following provision.

H. Coating: All requirements pertaining to thickness, application and curing of coating indicated for straight pipe shall apply to specials. Unless otherwise indicated the coating on the buried portion of a pipe section passing through a structure wall shall extend to the center of the wall, or to the wall flanges, if one is indicated. Pipe above ground or in structures shall be shop primered and field-painted in accordance with Section 09 90 01 – Protective Coatings.

I. Marking: A mark indicating the true vertical axis of the special shall be placed on the top and bottom of the special.

J. Shop Welded Surfaces: All weld seams on pipe surfaces that will have a flexible tape or polyolefin coating in accordance with AWWA C209, C214, C215, or C216 shall be ground such that the maximum weld bead height will not exceed 1/32 inch. All ground weld seams shall be smooth and free of all burrs.

K. Portions of wall sleeves that penetrate into hydraulic structures and will be embedded into concrete shall be shop lined and coated in accordance with requirements for submerged conditions as outlined in Section 09 90 01 – Protective Coatings.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all fittings, closure pieces, elbows, bends, reducers, wyes, tees, crosses, outlets, manifolds, and other steel plate specials, bolts, nuts, gaskets, jointing materials, and all other appurtenances as indicated to provide a complete and workable installation. Where pipe support details are indicated, the supports shall conform thereto and shall be placed as indicated; provided, that the support for all exposed piping shall be complete and adequate regardless of whether or not supporting devices are specifically indicated. Where indicated, concrete thrusts blocks and welded joints shall be provided. At all times when the Work of installing pipe is not in progress, all openings into the pipe and the ends of the pipe in trenches or structures shall be kept tightly closed to prevent entrance of animals and foreign materials.

B. Take all necessary precautions to prevent the pipe from floating due to water entering the trench or from backfilling with CLSM. The Contractor shall assume full responsibility for any damage due to this cause and shall at its own expense restore and replace the pipe to its specified condition and grade if it is displaced due to floating. Maintain the inside of the pipe free from foreign materials and in a clean and sanitary condition until its acceptance by the Owner.

C. Unless otherwise indicated, all specials shall be installed in full conformance with Section 33 11 11 - Steel Pipe, and other applicable sections of these Contract Documents.

END OF SECTION

SECTION 33 13 00
WATER PIPELINE TESTING AND DISINFECTION

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall perform flushing and testing of all pressure pipelines and appurtenant piping and disinfection of all pipelines and appurtenant piping for potable and fire water, complete.

B. This specification applies to all pipelines requiring hydrostatic tests (water medium) regardless of the pipeline service medium.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI/AWWA B300	Hypochlorites
ANSI/AWWA B301	Liquid Chlorine
ANSI/AWWA C206	Field Welding of Steel Water Pipe
ANSI/AWWA C651	Disinfecting Water Mains

1.3 CONTRACTOR SUBMITTALS

A. A testing schedule, including proposed plans for water conveyance, control, disposal, and disinfection shall be submitted in writing for approval a minimum of 7 days before testing is to start.

B. A copy of the Utah Pollutant Discharge Elimination System (UPDES) permit application shall be submitted a minimum of 30 days prior to the proposed date to start testing. A copy of the approved UPDES permit shall be submitted prior to the start of testing.

C. Chlorine residual test data and bacteriological test data shall be submitted to document the results of the pipeline disinfection. Tests shall be conducted 24 hours after the start of disinfection.

PART 2 - PRODUCTS

2.1 MATERIALS REQUIREMENTS

A. All test equipment, chemicals for chlorination, temporary valves, bulkheads, or other water control equipment and materials shall be determined and furnished by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to the construction or its future function.

B. Used pressure gauges shall be recertified prior to testing.

C. Chlorine for disinfection shall be in the form of liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets.

D. Liquid chlorine shall be in accordance with the requirements of ANSI/AWWA B301. Liquid chlorine shall be used only:
   1. In combination with appropriate gas flow chlorinators and ejectors;
   2. Under the direct supervision of an experienced technician;
   3. When appropriate safety practices are observed.

E. Sodium hypochlorite and calcium hypochlorite shall be in accordance with the requirements of ANSI/AWWA B300 - Hypochlorite.

PART 3 - EXECUTION

3.1 GENERAL

A. Water for testing and disinfecting water pipelines shall be furnished by the Owner. The Owner will also provide a meter for use by the Contractor. The Contractor shall make all necessary provisions for conveying the water from the source to the points of use, and disposal of the water (and dechlorinating - where applicable).

B. All pressure pipelines (including HDPE line) shall be tested. Disinfection shall be accomplished by chlorination for all pipelines providing potable water or connected to a potable water system. All chlorinating and testing operations shall be performed in the presence of the Engineer.

C. Disinfection operations shall be scheduled as late as possible during the contract time period so as to assure the maximum degree of sterility of the facilities at the time the Work is accepted by the Owner. Samples for bacteriological testing shall be collected by the Contractor, and testing shall be performed by the Owner laboratory and at the expense of the Contractor. Results of the bacteriological testing shall be satisfactory with the State Department of Health or other appropriate regulatory agency.

D. Pipeline pressure tests will include the following tests:
   1. Air test of double welded lap joints.
   2. Hydrostatic pressure test of the complete pipeline, in segments as required to match pipe pressure class.
   3. Contractor shall conduct the discharge in accordance with the Utah Pollutant Discharge Elimination System (UPDES) permit from the Utah Division of Environmental Quality (UDEQ). The Contractor shall apply a reducing agent to the discharged water to neutralize the chlorine residual and meet the chlorine residual limit required under the permit. The Owner shall conduct the water quality sampling of the discharge as required by the permit. The Contractor shall notify local agencies, secure appropriate other permits and approvals, and provide erosion control measures for any releases as appropriate. Release of water after pipeline testing and disinfection have been completed shall be only if acceptable to the Engineer.

E. Notification: Notify the Engineer at each of the following stages:
   1. Three working days prior to the start of filling the pipeline with water.
   2. Three working days prior to the start of chlorination.
   3. Twenty-four hours before withdrawing samples for bacteriological testing.
   4. Three working days prior to the start of flushing.

3.2 VISUAL INSPECTION

A. All welds shall be 100% visually inspected in accordance with ANSI/AWS D1.1, Table 6.1; Visual Inspection Acceptance Criteria for Statically Loaded Non-Tubular Connections.

3.3 AIR TEST

A. All double welded lap joint or double gasket Carnegie joint shall be pressure tested to a minimum of 40-psi air pressure for a period of 10 minutes per AWWA C206. No air leakage will be allowed.

B. If the test pressure drops below 40 psi, paint the welds with a soap solution. Mark any leaks indicated by the escaping gas bubbles.

C. Any joints which leak shall be repaired and retested.

3.4 HYDROSTATIC TESTING OF PIPELINES

A. Prior to hydrostatic testing, all pipelines shall be flushed or blown out as appropriate. Test all pipelines either in sections or as a unit. No section of the pipeline shall be tested until all field-placed concrete or mortar has attained an age of 14 days. The test shall be made by closing valves when available, or by placing temporary bulkheads in the pipe and filling the line slowly with water. The Contractor shall be responsible for ascertaining that all test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to or movement of the adjacent pipe. Any unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test, to avoid movement and damage to piping and equipment. Provide sufficient temporary air tappings in the pipelines to allow for evacuation of all entrapped air in each pipe segment to be tested. After completion of the tests, such taps shall be permanently plugged. Care shall be taken to see that all air vents are open prior to and during filling.

B. The pipeline shall be filled at a rate not to exceed 2-feet per second as calculated by using the cross-sectional area based on the inside diameter of the pipe and which will not cause any surges or exceed the rate at which the air can be released through the air valves at a reasonable velocity and all the air within the pipeline shall be properly purged. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb what water it will and to allow the escape of air from any air pocket. No personnel shall be within or enter any vault or confined space subject to flooding during the initial filling and for a 24 hour period. After the 24 hour period bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the Engineer shall be taken.

C. The hydrostatic test shall consist of holding the test pressure on the pipeline for a period of 4 hours. The test pressure for all pipelines downstream of the finished water pumps and

distribution and snowmaking pumps shall be 380 psi minimum. Test pressure for all raw water influent (RWI) lines in the yard shall be 29 psi minimum. Test pressure for all other water lines shall be 50 psi. Test pressure measurement shall be at the low end of the respective alignments. All visible leaks shall be repaired in a manner acceptable to the Engineer.

D. The maximum allowable leakage for distribution and transmission pipelines shall be 10 U.S. gallons per inch of diameter per mile of pipe per 24 hours for pipe with 40-foot or greater lengths between joints and with rubber-gasketed joints and 20 U.S. gallons per inch of diameter per mile of pipe per 24 hours for pipe with 20-foot or less lengths between joints and with rubber-gasketed joints. The maximum leakage for yard piping shall be as shown on the Piping Schedule. Pipe with welded joints shall have no leakage.

E. In the case of pipelines that fail to pass the prescribed leakage test, determine the cause of the leakage, take corrective measures necessary to repair the leaks, and again test the pipelines at no additional cost to the Owner.

F. The pipeline shall be drained after successful completion of the hydrostatic test.

3.5 DISINFECTING PIPELINES

A. General: All potable water pipelines shall be disinfected in accordance with the requirements of ANSI/AWWA C651 - Disinfecting Water Mains as modified herein.

B. Prior to disinfecting the pipeline for potable water services and before placing into service for other water pipelines, flush the pipeline to remove any debris, rocks, or other foreign material that may have entered the pipe. Flushing shall be carried out such that the velocities in the pipe exceed 2.5 feet per second. Provide all required material, labor and equipment to complete flushing. Contractor shall provide the water for flushing. Make appropriate provision and preparations for disposal of flushing water, satisfying all local, state and federal rules, laws, regulations and ordinances.

C. Continuous Feed Method: Disinfect in accordance with ANSI/AWWA C651 except that:
   1. The water in the pipe shall contain 50 mg/l free chlorine.
   2. After 24 hours of disinfection, the residual free chlorine shall be at least 25 mg/l at the pipeline extremities.

D. Slug Feed Method: Disinfect in accordance with ANSI/AWWA C651.

E. Chlorinating Valves: During the process of chlorinating the pipelines, all valves and other appurtenances shall be operated while the pipeline is filled with the heavily chlorinated water.

F. Final Flushing: After the applicable retention period, the heavily chlorinated water shall be flushed from the pipeline until chlorine measurements show that the concentration in the water leaving the pipeline is no higher than that generally prevailing in the system or is acceptable for domestic use. If there is any question that the chlorinated discharge will cause damage to the environment, a reducing agent shall be applied to the water to neutralize thoroughly the chlorine residual remaining in the water. See the appendix of AWWA C651 for acceptable neutralization methods for heavily chlorinated water.

G. Sampling Ports: The Contractor shall provide sampling ports along the pipeline as defined in AWWA C651. Taps may be made at manways and air valves to help facilitate the spacing requirement.

H. Bacteriological Testing: After final flushing and before the pipeline is placed in service, two consecutive sets of samples shall be collected at least 24 hours apart by the Contractor from the end of the line and at other locations as designated by the Engineer, and shall be tested by the Owner for bacteriological quality in accordance with the requirements of AWWA C651. For this purpose, the pipe shall be refilled with fresh potable water and left for a period of 24 hours before any samples are collected. If the initial disinfection fails to produce satisfactory bacteriological results or if other water quality is affected, the new main may be reflushed and shall be resampled. If check samples also fail to produce acceptable results, the main shall be rechlorinated by the continuous-feed or slug method until satisfactory results are obtained – that being two consecutive sets of acceptable samples taken 24 hours apart.

3.6 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before they are installed. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

END OF SECTION

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SECTION 33 13 01
HYDRAULIC STRUCTURES TESTING AND DISINFECTION

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall perform cleaning, flushing, disinfection and testing of all hydraulic structures and appurtenant piping, including conveyance of test water from Owner-designated source to point of use, and including all disposal of testing and disinfection water, complete and acceptable, all in accordance with the requirements of the Contract Documents.

1.2 REFERENCE STANDARDS

A. Commercial Standards:

ANSI/AWWA B300	Hypochlorites
ANSI/AWWA B301	Liquid Chlorine
ANSI/AWWA C651	Disinfecting Water Mains
ANSI/AWWA C652	Disinfection of Water-Storage Facilities
ANSI/AWWA C653	Disinfection of Water Treatment Plants

APHA/AWWA/WPCF Standard Methods for the Examination of Water and Wastewater (16th edition)

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures.

B. A testing schedule, including proposed plans for water conveyance, control, disposal, and disinfection, shall be submitted in writing for approval a minimum of 2 days before testing is to start.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. All temporary valves, bulkheads, or any other control equipment shall be as determined by the Contractor subject to the Engineer's review.

B. Chlorine for disinfection shall be in the form of liquid chlorine or sodium hypochlorite solution. Liquid chlorine shall be in accordance with the requirements of ANSI/AWWA B301; sodium hypochlorite shall be in accordance with the requirements of ANSI/AWWA B300. Liquid chlorine shall be used only (1) in combination with appropriate gas flow chlorinators

and ejectors; (2) under the direct supervision of an experienced technician; and (3) when appropriate safety practices are observed.

PART 3 - EXECUTION

3.1 GENERAL

A. Water for testing and disinfecting will be furnished by the Owner; however, the Contractor shall make all necessary provisions for conveying the water from the Owner-designated source to the points of use. The Contractor shall be responsible for all costs associated with retesting. Water supplied by the Owner for retesting will cost the Contractor $150 per acre foot for water used.

B. All hydraulic structures and appurtenant pressure piping shall be tested; those for potable water shall also be disinfected. Disinfection shall be accomplished by chlorination. All chlorinating and testing operations shall be done in the presence of the Engineer. In the case of a reservoir, testing and disinfecting operations shall be combined.

C. Disinfection operations shall be scheduled by the Contractor as late as possible during the contract time period so as to assure the maximum degree of sterility of the facilities at the time the Work is accepted by the Owner. Release of water from structures, after testing and disinfecting have been completed, shall be acceptable to the Engineer.

3.2 PRELIMINARY CLEANING AND FLUSHING

A. Prior to both testing and disinfecting, all hydraulic structures shall be cleaned by thoroughly hosing down all surfaces with a high-pressure hose and nozzle. All water, dirt, and foreign material accumulated in this cleaning operation shall be removed from the structure. The water supply for the washdown system is supplied by Owner. The Owner will pay for water for the initial cleaning and flushing. Any additional cleaning and flushing shall be at the Contractor's expense.

3.3 TESTING OF HYDRAULIC STRUCTURES AND PIPELINES

A. General: Testing shall be performed prior to backfilling. Testing shall be performed no sooner than 14 days after all portions of structure walls and associated roof systems have been completed. The structure shall be filled with water to the maximum operating water surface. The rate of filling shall not exceed 48 inches of depth per day. All leakage shall be repaired.

B. Leakage Test Requirements: After the structure has been filled, the water loss leakage test shall be performed as follows: an initial water level reading shall be made. Seven days following the initial reading, a second reading shall be made. The structure shall be considered to have passed the test if water loss during the 7-day period, as computed from the two water level readings, does not exceed 0.2 percent of the total volume of water in the structure, after allowance is made for evaporation loss. If intermediate readings or observed leakage indicate that the allowable leakage will be exceeded, the test may be terminated before the end of the 7-day period and appropriate action taken to correct the problem before commencing a new 7-day test period. Should the structure fail to pass the test, the test shall

be repeated for up to 3 additional 7-day test period. If, at the end of 28 days, the structure still fails to pass the leakage test, the Contractor shall empty the structure as acceptable to the Engineer and shall examine the interior for evidence of any cracking or other conditions that might be responsible for the leakage.

C. Piping shall be tested as specified in Section 33 13 00 - Water Pipeline Cleaning, Testing and Disinfection.

D. Structural Repairs and Visible Leakage: The Contractor shall repair any cracks. Cracks shall be grooved and sealed with Xypex in accordance manufacturer's instructions and Contract Drawings. Any evidence of leakage shall be repaired. Following these operations, the Contractor shall again test the hydraulic structure. The structure will not be accepted as completed until the water loss leakage test is passed and all visible leakage repaired. In the case of a reservoir, the retesting shall again be combined with disinfection.

3.4 DISINFECTION OF HYDRAULIC STRUCTURES AND PIPELINES

A. General: Hydraulic structures which store or convey culinary potable water shall be disinfected by chlorination. Chlorination of hydraulic structures shall be performed in accordance with the requirements of ANSI/AWWA C652 using a combination of chlorination Methods 2 and 3 as modified within this Section. All piping shall be disinfected as specified in Section 33 13 00 - Water Pipeline Cleaning, Testing and Disinfection.

B. Chlorination: A chlorine solution (about 200 mg/l) shall be sprayed on all interior surfaces of the structure. The structure shall then be partially filled with water to a depth of approximately one-foot. During the partial filling operation, a chlorine-water mixture shall be injected by means of a chlorinating device in such a way as to give a uniform chlorine concentration during the entire filling operation. The point of application shall be such that the chlorine solution will mix readily with the inflowing water. The dosage applied to the water shall be sufficient to provide a chlorine residual of at least 50 mg/l upon completion of the partial filling operation. The Contractor's attention is directed that all precautions shall be taken to prevent the chlorine solution from flowing back into the inlet water supply lines. After the partial filling has been completed, sufficient water shall be drained from the lower ends of appurtenant piping to ensure filling the lines with the chlorinated water.

C. Retention: Chlorinated water shall be retained in the partially filled structure and appurtenant piping long enough to destroy all non-spore-forming bacteria, and in any event, for at least 24 hours. After the chlorinated water has been retained for the required time, the free chlorine residual in the structure and appurtenant piping shall be at least 25 mg/l. All valves shall be operated while the lines are filled with the heavily chlorinated water.

D. Final Filling: After the chlorine residual has been checked, and has been found satisfactory, the water level in the structure shall be raised to its working water level elevation by adding potable water. Before final filling is commenced, the quantity of chlorinated water remaining in the structure after filling the piping shall, unless otherwise acceptable to the Engineer, be sufficient, when the water level is raised to its final elevation to produce a free chlorine residual of between 1 and 2 mg/l. After the structure has been filled, the chlorine residual of the water shall be determined. If the chlorine residual is less than 1 mg/l, an additional chlorine dosage shall be added to the water in the structure. If the chlorine residual is greater

than 2 mg/l, the structure shall be partially emptied and additional potable water added. In no case shall water be released prior to the expiration of the required retention period.

3.5 BACTERIOLOGIAL SAMPLING AND TESTING

A. Disinfected water storage facilities shall be sampled and tested in accordance with ANSI/AWWA C652. Bacteriological testing shall be performed by a certified testing laboratory acceptable to the Owner and paid for by the Contractor. Results of the testing shall be satisfactory to the State Department of Health or other appropriate regulatory agency.

3.6 CONNECTIONS TO EXISTING WATER SYSTEM

A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before they are installed. Thorough flushing shall be started as soon as the connection is completed and shall be continued until all discolored water is eliminated.

END OF SECTION

SECTION 33 41 03
PVC NON-PRESSURE PIPE, RUBBER JOINTS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide PVC non-pressure pipe and appurtenant work, complete and in place, in accordance with the Contract Documents.

B. This Section covers pipe from 4 to 48 inches diameter nominal size.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ASTM D 1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM F 1803	Standard Specification for Poly (Vinyl Chloride)(PVC) Closed Profile Gravity Pipe and Fittings Based on Controlled Inside Diameter
ASTM D 2444	Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)
ASTM D 2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
ASTM D 3212	Joints for Drain and Sewer Plastic Pipe Using Flexible Elastomeric Seals
ASTM F 477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 679	Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Gravity Sewer Pipe and Fittings
ASTM F 794	Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 913	Thermoplastic Elastomeric Seals (Gaskets) for Joining Plastic Pipe

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 20 –Submittal Procedures.

B. Shop Drawings: The Contractor shall submit shop drawings and laying diagrams of pipe, joints, bends, special fittings, and piping appurtenances.

C. Certificates: The Contractor shall submit manufacturer's certificate that pipe conforms to these specifications.

PART 2 - PRODUCTS

2.1 GENERAL

A. Pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, and minimum pipe stiffness in psi.

B. The Contractor shall also require the manufacturer to mark the date of extrusion on the pipe. This dating shall be done in conjunction with records to be held by the manufacturer for 2 years, covering quality control tests, raw material batch number, and other information deemed necessary by the manufacturer.

2.2 PIPE

A. Pipe shall conform to one of the following requirements
   1. Solid Wall Pipe (4" through 15") - ASTM D 3034, SDR 35.
   2. Solid Wall Pipe (18" through 48") -- ASTM F 679 – 46 psi.
   3. Ribbed Pipe (21" through 48") - ASTM F 794
   4. Closed Profile Wall Pipe (21" through 54") - ASTM F 1803 (Vylon or approved equal only)

B. Material for PVC pipe shall conform to the requirements of ASTM D 1784 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds, for cell classification 12454-C or 12364-A as defined therein. The manufacturer shall test a sample from each batch according to ASTM D 2444 - Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).

C. Joints shall conform to ASTM D 3212. Elastomeric seals for compression type joints shall conform to the requirements of ASTM F 477, ASTM F 913 - Thermoplastic Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

2.3 FITTINGS

A. All fittings shall be of the same material as the pipe, molded or formed to suit the pipe size and end design, in required configurations.

B. The stiffness of the fittings shall be not less than the stiffness of adjoining pipe.

PART 3 - EXECUTION

3.1 GENERAL

A. Laying, jointing, and testing for defects and for leakage shall be performed in the presence of the Engineer, and shall be subject to approval before acceptance. Material found to have defects will be rejected and the Contractor shall promptly remove such defective materials from the Site.

B. Installation shall conform to the requirements of ASTM D 2321, instructions furnished by the pipe manufacturer, and to the supplementary requirements herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.2 HANDLING AND STORAGE

A. Handling
   1. Handling of the PVC pipe shall be done with implements, tools, and facilities as recommended by the pipe manufacturer to ensure that the pipe is not damaged in any manner during storage, transit, loading, unloading, and installation.
   2. Pipe shall be inspected both prior to and after installation in the trench and all defective lengths shall be rejected and immediately removed from the working area.
   3. Fittings shall be lowered into trench by means of rope, cable, chain, or other means without damage. Cable, rope, or other devices used for lowering fitting into trench, shall be attached around exterior of fitting for handling. Under no circumstances shall the cable, rope, or other device be attached through the fitting interior for handling or shall pipe or fittings be dropped or dumped into the trench.

B. Storage: Pipe should be stored, if possible, at the Site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to bell ends of the pipe. Pipe should be stored in such a way as to prevent sagging or bending and be protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Gaskets should be stored in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.3 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of Section 31 23 00 – Earthwork and the Drawings.

3.4 LAYING PIPE

A. Pipe sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointings, the bedding for the pipe shall be checked for firmness and uniformity of slope.

B. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, or any other method that may fracture the pipe or will produce ragged, uneven edges.

C. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying. All openings in the pipe line shall be closed with water tight expandable type sewer plugs or PVC test plugs at the end of each day's operation or whenever the pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.

D. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the Work shall be the Contractor's responsibility.

E. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the Contractor in cooperation with owners of such utility structures. Unless otherwise indicated, protection of existing utility structures shall be the Contractor's responsibility.

3.5 FIELD JOINTING

A. Each pipe compression type joint shall be joined with a lock-in rubber ring and a ring groove that is designed to resist displacement during pipe insertion.

B. The ring and the ring seat inside the bell shall be wiped clean before the gasket is inserted. A thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall be then forced into the ring to complete the joint.

C. Fittings shall be carefully connected to pipe, and joint shall be checked to insure a sound and proper joint.

D. When pipe laying is not in progress, the open ends of the pipe shall be closed to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe which has floated shall be removed from the trench, cleaned, and relaid in an acceptable manner. No pipe shall be laid when, in the opinion of the Engineer, the trench conditions or weather are unsuitable.

3.6 SMALL DIAMETER LATERALS (SEWER LATERAL CONNECTIONS)

A. Laterals shall extend from the manhole, wye branch or similar fitting, as indicated in the Drawings. Wye fitting or other connection shall be positioned in the mainline such that it enters the mainline at an angle of at least 45 degrees from horizontal. Connections requiring a connection angle of less than 45 degrees shall be approved by the Engineer.

B. Install a 22.5 degree or 45-degree bend, or combination of bends, as required on the mainline wye to obtain the proper alignment and grade.

C. Lateral connections to manhole shall be made as directed in Section 33 05 16 – Precast Concrete Manholes and Vaults.

D. Laterals shall be installed along the indicated horizontal alignment with a uniform slope, free of low spots or adverse grades. Minimum slopes shall be 1/4 inch per foot for 4" diameter laterals and 1/8 inch per foot for 6" diameter laterals.

E. Cleanouts shall be installed on laterals at a horizontal spacing not to exceed 100 feet and at the locations indicated in the Drawings.

F. Any one bend (horizontal or vertical) shall not exceed 45 degrees and no more the two bends (horizontal or vertical) shall be installed without a cleanout.

G. Laterals shall be installed in accordance with all applicable requirements of the local plumbing codes.

3.7 INSTALLATION OF METALLIC LOCATING TAPE

A. Polyvinyl chloride pipelines shall be provided with a metallic locating tape laid along the centerline of the pipe trench at a depth of 18 inches below finished grade OR above top of pipe. The Contractor shall furnish manufacturer's literature, completely describing the tape proposed to be furnished. No tape shall be used prior to receipt of written approval of the Engineer.

3.8 TESTING

A. Field testing of gravity sewer pipe shall conform to the requirements of Section 33 08 00 – Gravity Piping Testing and Inspection.

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SECTION 33 41 05
DUCTILE IRON PIPE (AWWA C151, MODIFIED)

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall furnish and install ductile iron pipe and all appurtenant Work, complete in place, all in accordance with the requirements of the Contract Documents.

1.2 REFERENCE STANDARDS

A. Commercial Standards:

ANSI/AWWA C104/A21.4	Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water
ANSI/AWWA C105/A21.5	Polyethylene Encasement for Ductile Iron Piping and Fittings for Water
ANSI/AWWA C110/A21.10	Ductile Iron and Gray Iron Fittings, 3-in. through 48-in. for Water and Other Liquids
ANSI/AWWA C111/A21.11	Rubber-Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings
ANSI/AWWA C115/A21.15	Flanged Ductile Iron and Gray-Iron Pipe with Threaded Flanges
ANSI/AWWA C150/A21.50	Thickness Design of Ductile Iron Pipe
ANSI/AWWA C151/A21.51	Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
ANSI/AWWA C153/A21.53	Ductile Iron Compact Fittings, 3-in. through 12-in. for Water and Other Liquids
AWWA C209	Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
ANSI/AWWA C600	Installation of Ductile Iron Water Mains and their Appurtenances
ASTM C150	Specification for Portland Cement

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings: The Contractor shall submit shop drawings of pipe and fittings in accordance with the requirements of Section 01 33 20 – Submittal Procedures, the requirements of the referenced standards and the following supplemental requirements as applicable and specified herein.
   1. Marking plan and details of standard pipe section showing dimensions, pipe joints, fitting and special fitting pressure rating and thickness, size, coating and lining data.
   2. Pipeline layout drawings showing the location of each pipe section, each special length, closure sections, location and angle of bends, outlets, location of valves, and other special fittings.

B. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section, as specified in the referenced standards and the following supplemental requirements:
   1. Physical and chemical properties.
      a. Hydrostatic Test Reports

C. Sample Costs: All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture, in accordance with the provisions of the referenced standards, as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

C. Test: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.

D. The Contractor shall perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.

E. In addition to those tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner

PART 2 - PRODUCTS

2.1 GENERAL

A. Standards: Mortar-lined ductile iron pipe shall conform to ANSI/AWWA C151, C104, and C105, subject to the following supplemental requirements. The pipe shall be of the diameter

and class shown, shall be furnished complete with rubber gaskets as indicated in the Contract Documents, and all flanges, specials and fittings shall be provided as required under the Contract Documents.

B. Handling and Storage: The pipe shall be handled by devices acceptable to the Engineer, designed and constructed to prevent damage to the pipe coating/exterior. The use of equipment which might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be suitably supported and shall be secured to prevent accidental rolling. All other pipe handling equipment and methods shall be acceptable to the Engineer.

C. Laying Lengths: Maximum pipe laying lengths shall be 20 feet with shorter lengths provided as required by the Drawings.

D. Finish: The pipe shall have smooth and dense interior surfaces, and shall be free from fractures, excessive interior surface crazing, and roughness.

E. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing shown on the Drawings. The locations of correction pieces and closure assemblies are shown on the Drawings. Any change in location or number of said items shall be acceptable to the Engineer.

F. Pipe shall be new and recently manufactured. Refurbished pipe shall not be provided.

2.2 PIPE DESIGN CRITERIA

A. General: Ductile iron pipe shall be designed in accordance with the requirements of ANSI/AWWA C150 as applicable and as modified in this Section.

B. Pipe Wall Thickness for Internal Pressure: The pipe shall be designed with a net thickness to withstand the design pressure in accordance with the hoop stress formula.

C. Pipe Wall Thickness for External Load: The pipe shall also be designed with a net thickness to withstand internal loads using ANSI/AWWA C150 Design Equation (2) with the appropriate bending moment and deflection coefficients for Laying Condition Types 4 and 5 as applicable.

D. The pipe deflection shall be checked using ANSI/AWWA C150 Design Equation (3) and the coefficients stated above. The allowable deflection shall not exceed 0.0225 times the nominal diameter.

E. In lieu of ANSI/AWWA C150 Design Equation (4), the earth loads will be computed using the following two equations for trench or embankment loading as applicable:

1. Trench Condition:
   a. $W_d = C_d w B_d 2$,
   b. Where:
   c. W_d = Earth load in pounds per linear foot
   d. C_d = Calculation Coefficient
   e. Ku1 = 0.13
   f. w = 120 lb/ft3

g. B_d = Trench width at top of pipe, feet

2. Positive Projecting Embankment Condition:
   a. Wc = CcwBc2
   b. Where:
   c. Wc = Earth load in pounds per linear foot
   d. Cc = Calculation Coefficient (based on rsdP of 0.25)
   e. Ku1 = 0.13
   f. w = 120 lb/ft3
   g. Bc = Trench width at top of pipe, feet

F. The above two formulas are based on a depth of cover of 10 feet or greater. For depths of cover of less than 10 feet, HS-20 live load shall be included. For depths of cover of three feet or less, HS-20 live load plus impact shall be included. The determination of live load and impact factors shall be as recommended by AASHTO in "Standard Specifications for Highway Bridges."

G. If the calculated deflection, $Defl_x$, exceeds 0.0225 times the nominal diameter, the pipe class shall be increased.

H. Minimum Pipe Wall Thickness: In addition to the requirements of this Section, the minimum wall thickness shall be in accordance with Table 50.5 of ANSI/AWWA C150.

2.3 MATERIALS

A. Ductile Iron Pipe: Pipe materials shall conform to the requirements of ANSI/AWWA C151.

B. Cement: Cement for mortar lining shall conform to the requirements of ANSI/AWWA C104, provided that cement for mortar lining shall be Type V. A fly ash or pozzolan shall not be used as a cement replacement.

2.4 SPECIALS AND FITTINGS

A. Fittings for ductile iron pipe shall conform to the requirements of ANSI/AWWA C153/A21.53 or ANSI/AWWA C110/A21.10 for diameters 3-inch through 48-inch and shall have a minimum pressure rating of 350 psi. Ductile iron fittings larger than 48-inch shall conform to the above-referenced standard with the necessary modifications for the larger size.

2.5 DESIGN OF PIPE

A. General: The pipe furnished shall be ductile iron pipe, mortar-lined with rubber-gasketed joints as shown.

B. Manufacturing Requirements: The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements previously stated and, except as hereinafter modified, shall conform to ANSI/AWWA C151.

C. Pipe Dimensions**:** The pipe shall be of the diameter and class shown. The minimum wall thickness for each pipe size shall be as specified or shown.

D. Fitting Dimensions: The fittings shall be of the diameter and class shown.

E. Joint Design: Ductile iron pipe and fittings shall be furnished with mechanical joints, push-on joints, flanged joints, and restrained joints as required.

1. Mechanical and push-on joints shall conform to ANSI/AWWA C111/A21.11.
2. Restrained Joint:
    a. Manufactured proprietary joint that mechanically restrains pipe to adjoining pipe without setscrews or devices with shoes or wedges activated by setscrews.
    b. The use of devices utilizing setscrews or with shoes or wedges activated by setscrews or bolts shall not be allowed. Except where allowed by governing agencies as temporary thrust restraint.
    c. Rated at minimum working pressure equal to or greater than that of the pipe class.
    d. The use of field-lock, gripper ring type restraining devices shall be limited to only locations where unforeseen field conditions or closure places require the pipe to be field fit, cut, and joined, and as approved by the Engineer. Where field locking, gripper ring type restraining devices are used, the gripper ring shall be installed a minimum of one full pipe length away from the fitting or closure. The installation of gripper ring type restraining devices where used shall be in strict accordance with the manufacturer's installation instructions.
    e. Field welding of ductile iron pipe and fitting shall not be allowed.
3. Flanged joints shall conform to ANSI/AWWA C115/A21.15.

F. Joint Clearances: For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The Contractor shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.

G. Coating and Linings Held Back: Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe as shown, or as otherwise acceptable to the Engineer.

2.5 CEMENT-MORTAR LINING

A. Cement-Mortar Lining for Shop Application: Except as otherwise provided herein, interior surfaces of all ductile iron pipe, fittings and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C104. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at the delivery site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications.

B. Lining Thickness: The minimum lining thickness shall be as follows:

Nominal Pipe Diameter (in)	Minimum Lining Thickness (in)
3-12	1/8

14-24	3/16
30-54	1/4

C. Protection of Pipe Lining/Interior: All shop-applied cement mortar lining shall be given a seal coat of asphaltic material in conformance with ANSI/AWWA C104.

2.6 EXTERIOR COATING OF PIPE

A. Exterior Coating of Exposed Piping: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then coated according to the requirements of Section 09 97 01 – Pipeline Coatings and Linings.

B. Exterior Coating of Buried Piping: The exterior of the pipe shall be prepared and have a dielectric coating applied in conformance with Section 09 97 01 – Pipeline Coatings and Linings.

2.7 SOURCE QUALITY CONTROL

A. Factory Tests: In accordance with AWWA C104, C105, C110, C111, C115, C150, C151, C153, and C606.

PART 3 - EXECUTION

3.1 GENERAL

A. Laying, jointing, testing for defects and for leakage shall be performed in the presence of the Engineer, and shall be subject to approval before acceptance. Material found to have defects will be rejected and the Contractor shall promptly remove such defective materials from the Site.

B. Installation shall conform to the requirements of AWWA C600, instructions furnished by the pipe manufacturer, and to the supplementary requirements herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.2 INSTALLATION OF PIPE

A. Handling and Storage: All pipe, fittings, etc., shall be carefully handled and protected against damage, impact shocks, and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground but shall be supported in a manner that will protect the pipe coating against injury whenever stored at the trench site or elsewhere. No pipe shall be installed where the lining or coating show defects that may be harmful as determined by the Engineer. Such damaged lining or coating shall be repaired, or a new undamaged pipe shall be furnished and installed.

B. Damaged Pipe: All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.

C. Contractor to Inspect Pipe: The Contractor shall inspect each pipe and fitting prior to installation to insure that there are no damaged portions of the pipe.

D. Trench excavation and backfill shall conform to the requirements of Section 31 23 00 – Earthwork. Care shall be taken to ensure that pipe zone material is compacted and in full contact with the haunches of the pipe and that the pipe is fully supported.

E. Clean Pipe: Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance, which may have collected thereon, and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the Work.
   1. Remove lumps, blisters, and excess asphaltic type coating from bell and spigot ends of each pipe. Wire brush outside of spigot and inside of bell and wipe clean, dry, and free from oil and grease before pipe is laid.
   2. Wipe ends of mechanical joint pipe and fittings and of rubber gasket joint pipe and fittings clean of dirt, grease, and foreign matter.

F. Pipe Laying: The pipe shall be installed in accordance with ANSI/AWWA C600.
   1. Direction of Laying: Lay pipe with bell end facing in direction of laying. For lines on an appreciable slope, face bells upgrade at discretion of Engineer.
   2. Mechanical Joint, Push-On Joint, and Restrained Joint Pipe: After first length of pipe is installed in trench, secure pipe in place with approved backfill material tamped under and along sides to prevent movement. Keep ends clear of backfill. After each section is jointed, place backfill as specified to prevent movement. For restrained joint pipe and fittings, after each section is jointed and restraining devices are completely installed, fully extend the completed joint and place backfill as specified to prevent movement before installation of the next section of pipe or fitting.
   3. Take precautions necessary to prevent floating of pipe prior to completion of backfill operation.
   4. When using movable trench shield, take necessary precautions to prevent pipe joints from pulling apart when moving shield ahead.
   5. Do not allow foreign material to enter pipe while it is being placed in trench.
   6. Close and block open end of last laid section of pipe to prevent entry of foreign material or creep of gasketed joints when laying operations are not in progress, at close of day's work, or whenever workers are absent from job.

G. Joining Push-On Joint Pipe and Mechanical Joint Fittings:
   1. Join pipe with push-on joints and mechanical joint fittings in strict accordance with manufacturer's recommendations.
   2. Provide special tools and devices, such as, special jacks, chokers, and similar items required for installation.
   3. Lubricate pipe gaskets using lubricant furnished by pipe manufacturer. No substitutes will be permitted.
   4. Clean ends of fittings of dirt, mud, and foreign matter by washing with water and scrubbing with a wire brush, after which, slip gland and gasket on plain end of pipe. If necessary, lubricate end of pipe to facilitate sliding gasket in place, then guide fitting onto spigot of pipe previously laid.

H. Founding Pipe: Pipe shall be laid directly on the Pipe Zone material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

I. Unforeseen Obstructions: Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed the maximum designed deflection recommended by the pipe manufacturer. No joint shall be misfit any amount that will be detrimental to the strength and water tightness of the finished joint.

J. Except for short runs which may be permitted by the Engineer, pipes shall be laid uphill on grades exceeding 10 percent. Pipe which is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. All bends shall be properly installed as shown.

K. Cold Weather Protection: No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

L. Pipe and Specials Protection: The openings of all pipe and specials shall be protected with suitable bulkheads to prevent unauthorized access by persons, animals, water or any undesirable substance. At all times, means shall be provided to prevent the pipe from floating.

M. Pipe Cleanup: As pipe laying progresses, the Contractor shall keep the pipe interior free of all debris. The Contractor shall completely clean the interior of the pipe of all sand, dirt, mortar splatter and any other debris following completion of pipe laying, pointing of joints and any necessary interior repairs prior to testing and disinfecting the completed pipeline.

N. Cutting Pipe: General: Cut pipe for inserting closure pieces in a neat and workmanlike manner without damaging pipe or lining and so as to leave a smooth end, at right angles to axis of pipe.
   1. Pipe: Cut pipe with milling type cutter or saw. Do not flame cut.
   2. Dressing Cut Ends: Dress cut ends of push-on joint pipe by beveling, as recommended by manufacturer.

O. Field Welding:
   1. Field welding of ductile iron pipe shall not be allowed.
   2. Field welding of bars for restrained joint systems will not be allowed. All welding shall be performed in pipe manufacturer's shop.

P. Field Installed Outlets: Field outlets may be installed with a saddle; however, the maximum nominal diameter of outlet for saddle shall be 2-inch. Opening in pipe shall be machine cut. Flame cut openings shall not be allowed.

3.3 RUBBER GASKETED JOINTS

A. Rubber Gasketed Joints: Immediately before jointing pipe, the bell end of the pipe shall be thoroughly cleaned, and a clean rubber gasket, lubricated with an approved vegetable-based lubricant, shall be placed in the bell groove. The spigot end of the pipe shall be carefully cleaned and lubricated with a vegetable-based lubricant. The spigot end of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted.

3.4 CORROSION PROTECTION

A. Polyethylene Encasement: Polyethylene encasement will not be allowed due to the groundwater fluctuation at site.

B. Dielectric Coating: The exterior of the pipe shall have a dielectric coating applied in conformance with Section 09 97 01 – Pipeline Coatings and Linings.

C. Bonded Joints: Joints shall be bonded in accordance with Section 13 47 13 – Cathodic Protection.

D. Galvanic Anodes: Galvanic Anodes shall be placed in accordance with Section 13 47 13 – Cathodic Protection.

E. Test Stations: Test stations for monitoring corrosion and to evaluate cathodic protection levels on the piping shall be installed per Section 13 47 13 – Cathodic Protection.

INSTALLATION OF PIPE APPURTENANCES

F. Protection of Appurtenances: Where the joining pipe is tape-coated, buried appurtenances shall be coated with cold-applied tape in accordance with ANSI/AWWA C209, Type II.

G. Installation of Valves: All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. The Contractor shall adjust all stem packing and operate each valve prior to installation to insure proper operation.

H. Valve Installation: All valves shall be installed so that the valve stems are plumb and in the location shown on the Drawings.

3.5 INSTALLATION OF METALLIC LOCATING TAPE

A. Buried pipelines shall be provided with a metallic locating tape laid along the centerline of the pipe trench at a depth of 18 inches below finished grade. The Contractor shall furnish manufacturer's literature, completely describing the tape proposed to be furnished. No tape shall be used prior to receipt of written approval of the Engineer.

3.6 FIELD TESTING AND DISINFECTION

A. Field testing shall conform to the requirements of Section 33 13 00 – Water Pipeline Testing and Disinfection as applicable.

END OF SECTION

SECTION 33 46 00
UNDERDRAINS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall furnish and install all specified drain piping, imported bedding, geotextile fabrics and all appurtenant work, complete and in place, in accordance with the Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 31 23 00 Earthwork

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ASTM D 1785	Polyvinyl Chloride Pipe

1.4 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 20 – Contractor Submittals.

B. Shop Drawings: Drawings and laying diagrams of all pipe, joints, bends, special fittings, and piping appurtenance.

C. Certificates: Manufacturer's certificates for all materials indicating conformance to the Contract Documents.

D. Samples: Samples of all the materials proposed for use on the Work. The samples shall be clearly marked to show the manufacturer's name and product identification and shall be submitted along with the manufacturer's technical data and application instructions.

1.5 QUALITY ASSURANCE

A. Testing: All materials testing will be based upon applicable ASTM Test Methods referenced herein for the materials specified.

B. All costs of such inspection and testing shall be the Contractor’s responsibility.

PART 2 - PRODUCTS

2.1 DRAIN PIPE

A. Drain pipe used for footing drains and under drains shall be PVC pipe as specified herein. Drain piping shall be perforated and non-perforated as noted in the drawings. Perforations shall be as specified herein.

B. Footing and under drain pipes shall be rigid PVC pipe conforming to the requirements of ASTM D 1785 Schedule 80 for polyvinyl chloride pipe and fittings. Perforations shall be located at four o'clock and eight o'clock positions. The perforations shall be drilled at a ¼-inch diameter spaced at 5 inches on center.

2.2 GRANULAR DRAINAGE MATERIALS

A. When called for, granular drainage backfill material shall be as specified in Section 31 23 00 – Earthwork as follows:
   1. Drain rock shall be Type H material specified in Section 31 23 00 – Earthwork

2.3 GEOTEXTILE FILTER FABRIC

A. Geotextile filter fabric shall be of non-woven needle-punched construction and consist of long-chain polymeric fibers. The geotextile fabric shall meet the following physical properties.

1.	Minimum thickness	60 mils
2.	Coefficient of water permeability	0.20 cm/sec
3.	Puncture strength	70 lbs

B. The geotextile filter fabric shall be as manufactured by Mirafi 140N, Trevira 1115 or equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. The Contractor shall notify the Engineer when the excavation has reached the final subgrade prior to placement of any under drain materials to allow examination of the foundation materials by the soils engineer.

D. Drain pipe shall be bedded in the type H gravel and the drain pipe installed with perforations placed down. The backfill of the drain pipe with drain rock shall proceed as detailed on the drawings placing the material around the pipe to provide a solid backing and to prevent lateral movement. Above the top of the pipe, compact the rock material with a vibratory plate, place the upper layer of geotextile fabric then proceed with the structural backfill as

specified in Section 31 23 00. All joints in the filter fabric shall be lapped a minimum of 18 inches. The filter fabric shall be extended to prevent migration of the backfill material.

3.2 PIPING INSTALLALTION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing, solidly in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirement indicated.
   1. Install piping pitched down in direction of flow, at a minimum slope of 0.25 percent.
   2. Provide recessed in excavation bottom to receive bells and pipe bell ends. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
   3. Apply and compact impervious fill material to raise low areas or where unsatisfactory bearing soil may occur.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fitting being connected. Reduction of pipe size in direction of flow is prohibited.

C. Excavate for underfloor drainage system after subgrade material has been compacted but before drainage fill has been placed. Grade bottom of trench excavations to required slope and compact to firm, solid bed for drain system.

D. Maintain swab or drag in piping with tight joints and pull past each joint as it is completed.

E. Extend piping and connect to sumps and storm drainage system, of sizes and in locations indicated. Terminate piping as indicated.

F. Provide piping with caps at locations indicated on the drawings. If pipe to be connected is already in place make connection.

3.3 FIELD QUALITY CONTROL

A. Testing: After installing drainage fill to top of pipe, test drain piping with water to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

3.4 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION

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SECTION 33 51 13
NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes fuel gas piping within the Building. Products include the following:
   1. Pipe, tube, fittings, and joining materials.
   2. Protective pipe and fitting coating.
   3. Piping specialties.
   4. Specialty valves.

1.3 PROJECT CONDITIONS

A. Gas System Pressure: 0.5 psig or less.

B. Design values of fuel gas supplied for these systems are as follows:
   1. Nominal Heating Value: 890 Btu/cu. ft.
   2. Nominal Specific Gravity: 0.6.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
   2. Pressure regulators. Include pressure rating, capacity, and settings of selected models.

B. Welding certificates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For natural gas specialties and accessories to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

B. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. NFPA Standard: Comply with NFPA 54, "National Fuel Gas Code.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and legally dispose of liquids from drips in existing gas piping. Handle cautiously to avoid spillage and ignition. Notify fuel gas supplier. Handle flammable liquids used by Installer with proper precautions and do not leave on premises from end of one day to beginning of next day.

1.7 COORDINATION

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Architect not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect's written permission.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PIPES, TUBES, FITTINGS, AND JOINING MATERIALS

A. Steel Pipe: ASTM A 53/A 53M; Type E or S; Grade B; black. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.
   1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
   2. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
   3. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
   4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
   5. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
   6. Joint Compound and Tape: Suitable for natural gas.
   7. Steel Flanges and Flanged Fittings: ASME B16.5.

8. Gasket Material: Thickness, material, and type suitable for natural gas.

2.4 PIPING SPECIALTIES

A. Flexible Connectors: ANSI Z21.24, copper alloy.

B. Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.

2.5 SPECIALTY VALVES

A. Valves, NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

B. Appliance Connector Valves: ANSI Z21.15 and CSA International listed.
   1. Available Manufacturers:
      a. American Valve Inc.
      b. B&K Industries, Inc.
      c. Brass Craft Manufacturing Co.
      d. Conbraco Industries, Inc.; Apollo Div.
      e. Jomar International Ltd.
      f. Mueller Co.; Mueller Gas Products Div.
      g. Robert Manufacturing Co.
      h. Watts Industries, Inc.; Water Products Div.

C. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.

D. Gas Valves, NPS 2 and Smaller: ASME B16.33 and CSA International-listed bronze body and 125 psig pressure rating.
   1. Available Manufacturers:
      a. Crane Valves.
      b. Grinnell Corp.
      c. Honeywell International Inc.
      d. Milwaukee Valve Company.
      e. Mueller Co.; Mueller Gas Products Div.
      f. NIBCO INC.
      g. Red-White Valve Corp.
      h. Watts Industries, Inc.; Water Products Div.
   2. Tamperproof Feature: Include design for locking.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural gas piping system to verify actual locations of piping connections before equipment installation.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off fuel gas to premises or section of piping. Perform leakage test as specified in "Field Quality Control" Article to determine that all equipment is turned off in affected piping section.

3.3 SERVICE ENTRANCE PIPING

A. Extend fuel gas piping and connect to fuel gas distribution for service entrance to building.
   1. Exterior fuel gas distribution system piping, service pressure regulator and service meter will be provided by gas utility.

B. Install dielectric fitting downstream from and adjacent to each service meter unless meter is supported from service-meter bar with integral dielectric fitting. Install shutoff valve downstream from and adjacent to dielectric fitting. Dielectric fittings are specified in Division 15 Section "Basic Mechanical Materials and Methods."

C. Install strainer upstream from each earthquake valve. Strainers are specified in Division 15 Section "Plumbing Specialties."

3.4 PIPING APPLICATIONS

A. Flanges, unions, transition, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, unless otherwise indicated.

B. Fuel Gas Piping, 2 psig or Less:
   1. NPS 1/2 and Smaller: NPS 3/4 steel pipe, malleable-iron threaded fittings, and threaded joints.
   2. NPS 3/4 and NPS 1: Steel pipe, malleable-iron threaded fittings, and threaded joints.

3.5 VALVE APPLICATIONS

A. Appliance Shutoff Valves for Pressure 0.5 psig or Less: Appliance connector valve or gas stop.

B. Appliance Shutoff Valves for Pressure 0.5 to 2 psig: Gas stop or gas valve.

C. Piping Line Valves, NPS 2 and Smaller: Gas valve.

D. Valves at Service Meter, NPS 2 and Smaller: Gas valve.

3.6 PIPING INSTALLATION

A. Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.
   1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.

2. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls.
   a. Exception: Tubing passing through partitions or walls.
3. In Walls: Gas piping with welded joints and protective wrapping specified in Part 2 "Protective Coating" Article may be installed in masonry walls, subject to approval of authorities having jurisdiction.
4. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
   a. Exception: Accessible above-ceiling space specified above.

B. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.
1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.

C. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels, unless indicated to be exposed to view.

D. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.

E. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

F. Connect branch piping from top or side of horizontal piping.

G. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

H. Install corrugated, stainless-steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.

I. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.

J. Install pressure gage downstream from each line pressure regulator. Pressure gages are specified in Division 15 Section "Meters and Gages."

K. Install flanges on valves, specialties, and equipment having NPS 2-1/2 and larger connections.

L. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.

3.7 JOINT CONSTRUCTION

A. Basic piping joint construction is specified in Division 15 Section "Basic Mechanical Materials and Methods."

B. Use materials suitable for fuel gas.
   1. Brazed Joints: Make with brazing alloy with melting point greater than 1000 deg F. Brazing alloys containing phosphorus are prohibited.

C. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.8 HANGER AND SUPPORT INSTALLATION

A. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.9 CONNECTIONS

A. Drawings indicate general arrangement of fuel gas piping, fittings, and specialties.

B. Install piping adjacent to appliances to allow service and maintenance.

C. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.

D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

E. Ground equipment according to Division 16 Section "Grounding and Bonding."
   1. Do not use gas pipe as grounding electrode.

F. Connect wiring according to Division 16 Section "Conductors and Cables."

3.10 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator, and specialty valve.
   1. Text: In addition to name of identified unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
   2. Nameplates, pipe identification, and signs are specified in Division 15 Section "Mechanical Identification."

3.11 PAINTING

A. Use materials and procedures in Division 9 painting Sections.

B. Paint exterior pressure regulators, and specialty valves.

1. Color: Gray.

3.12 FIELD QUALITY CONTROL

A. Test, inspect, and purge piping according to NFPA 54 and requirements of authorities having jurisdiction.

B. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

C. Verify capacities and pressure ratings of service meters, pressure regulators, valves, and specialties.

D. Verify correct pressure settings for pressure regulators.

E. Verify that specified piping tests are complete.

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DIVISION 40
PROCESS INTEGRATION

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SECTION 40 05 00
PIPING, GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall furnish and install all piping systems shown and specified, in accordance with the requirements of the Contract Documents. Each system shall be complete with all necessary fittings, hangers, supports, anchors, seismic restraints, expansion joints, flexible connectors, valves, accessories, heat tracing, insulation, lining and coating, testing, disinfection, excavation, backfill and encasement, to provide a functional installation.

B. The piping shown is intended to define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical drawings are not pipe construction or fabrication drawings. It is the Contractor's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, etc., for a complete and functional system.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI/ASME B1.20.1	Pipe Threads, General Purpose (inch)
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys
ANSI/AWWA C207	Steel Pipe Flanges for Water Works Service, Sizes 4 in through 144 in.
ANSI/AWWA C606	Grooved and Shouldered Joints
ANSI/AWS D1.1	Structural Welding Code
ASTM A 307	Specification for Carbon Steel Bolts and Studs, 6,000 psi Tensile
ASTM A 325	Specification for High-Strength Bolts for Structural Steel Joints
ASTM D 792	Test Methods for Specific Gravity and Density of Plastics by Displacement
ASTM D 2000	Classification System for Rubber Products in Automotive Applications

1.3 CONTRACTOR SUBMITTALS

A. Submit complete shop drawings and certificates, test reports, affidavits of compliance, of all piping systems, in accordance with the requirements in Section 01 33 20 – Submittal Procedures, and as indicated in the individual piping sections. The shop drawings shall include all necessary dimensions and details on pipe joints, fittings, fitting specials, valves, appurtenances, design calculations, and material lists. The submittals shall include detailed layout, spool, or fabrication drawings which show all pipe spools, spacers, adapters, connectors, fittings, and pipe supports and seismic restraints necessary to accommodate the equipment and valves provided in a complete and functional system.

B. All expenses incurred in making samples for certification of tests shall be borne by the Contractor at no increased cost to the Owner.

C. Submit as part of the shop drawings a statement from the pipe fabricator certifying that all pipes will be fabricated subject to a recognized Quality Control Program. An outline of the program shall be submitted to the Engineer for review prior to the fabrication of any pipe.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

B. Tests: Except where otherwise indicated, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards. Welds shall be tested as indicated. Perform all tests at no additional cost to the Owner.

C. Welding Requirements: All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.

D. Welder Qualifications: All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local, approved testing agency not more than 6 months prior to commencing Work on the pipeline. Machines and electrodes similar to those used in the Work shall be used in qualification tests. Furnish all material and bear the expense of qualifying welders at no increased cost to the Owner.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Where the assistance of a manufacturer's service representative is advisable, in order to obtain perfect pipe joints, supports, or special connections, furnish such assistance at no additional cost to the Owner.

1.6 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground, to provide protection against oxidation caused by ground contact. All defective or damaged materials shall be replaced with new materials.

1.7 CLEANUP

A. After completion of the Work, all remaining pipe cuttings, joining and wrapping materials, and other scattered debris, shall be removed from the site. The entire piping system shall be handed over in a clean and functional condition.

PART 2 - PRODUCTS

2.1 GENERAL

A. All pipes, fittings, and appurtenances shall be furnished in accordance with the requirements of the applicable Sections of Division 33 and this Section.

B. Miscellaneous Small Pipes: Miscellaneous small pipes and fittings shall be provided by the Contractor in accordance with the requirements of Section 40 00 03 - Mill Piping - Exposed and Buried and this Section.

C. Pipe Supports: All pipes shall be adequately supported in accordance with the requirements of Section 40 05 07 - Pipe Supports, and as indicated.

D. Lining: All requirements pertaining to thickness, applications, and curing of pipe lining, are in accordance with the requirements of the applicable Sections of Division 33, unless otherwise indicated.

E. Coating: All requirements pertaining to thickness, application, and curing of pipe coating, are in accordance with the requirements of the applicable Sections of Division 33, unless otherwise indicated. Pipes above ground or in structures shall be field-painted in accordance with Section 09 90 01 – Protective Coatings.

F. Pressure Rating: All piping systems shall be designed for the maximum expected pressure as defined in Section 33 13 00 - Water Pipeline Testing and Disinfection, or as indicated on the piping schedule.

G. Grooved Piping Systems: Piping systems with grooved joints and fittings may be provided, if approved by the Engineer, in lieu of screwed, flanged, welded, or mechanical joint systems for steel and ductile iron yard piping above and below ground within the property limits of pump stations, and similar installations. All grooved couplings on buried piping must be bonded. To assure uniform and compatible piping components, all grooved fittings, couplings, and valves shall be from the same manufacturer. The Contractor shall make the coupling manufacturer responsible for the selection of the correct style of coupling and gasket for each individual location.

2.2 PIPE FLANGES

A. Flanges: Where the design pressure is 150 psi or less, flanges shall conform to either ANSI/AWWA C207 Class D or ANSI B16.5 150-pound class. Where the design pressure is greater than 150 psi, up to a maximum of 275 psi, flanges shall conform to either ANSI/AWWA C207 Class E, Class F, or ANSI B16.5 150-pound class. However, AWWA flanges shall not be exposed to test pressures greater than 125 percent of rated capacity. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected. Where the design pressure is greater than 275 psi up to a maximum of 700 psi, flanges shall conform to ANSI B16.5 300-pound class. Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown. Attachment of the flanges to the pipe shall conform to the applicable requirements of ANSI/AWWA C207. Flanges for miscellaneous small pipes shall be in accordance with the standards specified for these pipes.

B. Blind Flanges: Blind flanges shall be in accordance with ANSI/AWWA C207, or with the standards for miscellaneous small pipes. All blind flanges for pipe sizes 12 inches and over shall be provided with lifting eyes in form of welded or screwed eye bolts.

C. Flange Coating: All machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

D. Flange Bolts: Contractor shall supply all bolts and nuts in conformance with Section 05 50 00 – Metal Fabrications. Studs and bolts shall extend through the nuts a minimum of 1/4 inch. All-thread studs shall be used on all valve flange connections, where space restrictions preclude the use of regular bolts.

E. Insulating Flanges: Insulated flanges shall have bolt holes 1/4 inch diameter greater than the bolt diameter.

F. Insulating Flange Sets: Insulating flange sets shall be provided by the Contractor where shown. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers and a steel washer. Insulating sleeves and washers shall be one piece when flange bolt diameter is 1-1/2 inches or smaller and shall be made of acetal resin. For bolt diameters larger than 1-1/2 inches, insulating sleeves and washers shall be two-piece and shall be made of polyethylene or phenolic. Steel washers shall be in accordance with ASTM A 325. Insulating gaskets shall be full-face.

G. Insulating Flange Manufacturers, or Equal
   1. JM Red Devil, Type E
   2. Maloney Pipeline Products Co., Houston
   3. PSI Products, Inc., Burbank, California.

H. Flange Gaskets: Contractor shall provide flange gaskets for all pipe flanges. Gaskets for flanged joints shall be full-faced, 1/16-inch thick compressed sheets of asbestos-free aramid fiber base, with nitrile binder and nonstick coating, suitable for temperatures to 700 degrees F, a pH of 1 to 11, and pressures to 1,000 psig. Blind flanges shall have gaskets covering the

entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted.

I. Flange Gasket Manufacturers, or Equal
   1. John Crane, Style 2160.
   2. Garlock, Style 3000.

2.3 THREADED INSULATING CONNECTIONS

A. General: Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.

B. Materials: Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other nonconductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.4 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

A. Construction: Cast mechanical-type couplings shall be provided where shown. The couplings shall conform to the requirements of ANSI/AWWA C606. Bolts and nuts shall conform to the requirements of Section 05 50 00 – Metal Fabrications. All gaskets for mechanical-type couplings shall be compatible with the piping service and fluid utilized, in accordance with the coupling manufacturer's recommendations. The wall thickness of all grooved piping shall conform with the coupling manufacturer's recommendations to suit the highest expected pressure. To avoid stress on equipment, all equipment connections shall have rigid-grooved couplings, or harness sets in sizes where rigid couplings are not available, unless thrust restraint is provided by other means. The Contractor shall have the coupling Manufacturer's service representative verify the correct choice and application of all couplings and gaskets, and the workmanship, to assure a correct installation.

B. Couplings for Steel Pipe, Manufacturers, or Equal
   1. Victaulic Style 44 with Type D Heavy Duty Grooved Adaptor Ends.

C. Ductile Iron Pipe Couplings, Manufacturers, or Equal
   1. Gustin-Bacon.
   2. Victaulic Style 31 (flexible or rigid grooving).
   3. Note: Ductile iron pipe couplings shall be furnished with flush seal gaskets.

D. Couplings for PVC Pipe, Manufacturers, or Equal
   1. Gustin-Bacon.
   2. Victaulic Style 775.
   3. Note: Couplings for PVC pipe shall be furnished with radius cut or standard roll grooved pipe ends. Grooved end couplings shall be used on PVC pipe only for Schedule 80 vent piping at the vaults. Grooved end couplings shall not be used for PVC C905 water pipe.

2.5 SLEEVE-TYPE COUPLINGS

A. Construction: Sleeve-type couplings shall be provided where indicated, in accordance with ANSI/AWWA C219 unless otherwise indicated, and shall be of steel with steel bolts, without pipe stop, and shall be of sizes to fit the pipe and fittings. The middle ring shall be not less than 1/4 inch in thickness and shall be either 5 or 7 inches long for sizes up to and including 30 inches and 10 inches long for sizes greater than 30 inches, for standard steel couplings, and 16 inches long for long-sleeve couplings. The followers shall be single-piece contoured mill section welded and cold-expanded as required for the middle rings. They shall be of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Bolts and nuts shall conform to the requirements of Section 05 50 00 – Metal fabrications. Buried sleeve-type couplings shall be epoxy-coated at the factory.

B. Pipe Preparation: The ends of the pipe, where indicated, shall be prepared for flexible steel couplings. Plain ends for use with couplings shall be smooth and round for a distance of 12 inches from the ends of the pipe, with outside diameter not more than 1/64 inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.

C. Gaskets: Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," grade 60, or equivalent suitable elastomer.
   1. The rubber in the gasket shall meet the following specifications:
      a. Color - Jet Black.
      b. Surface - Nonblooming.
      c. Durometer Hardness - 74 " 5.
      d. Tensile Strength - 1,000 psi Minimum.
      e. Elongation - 175 percent Minimum.
   2. The gaskets shall be immune to attack by impurities normally found in water or wastewater. All gaskets shall meet the requirements of ASTM D 2000, AA709Z, meeting Suffix B13 Grade 3, except as noted above. All gaskets shall be compatible with the piping service and fluid utilized.

D. Insulating Couplings: Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a rubber sleeve of an insulating compound in order to obtain insulation of all coupling metal parts from the pipe.

E. Restrained Joints: All sleeve-type couplings on pressure lines shall be harnessed unless thrust restraint is provided by other means. Harnesses shall be in accordance with the requirements of the appropriate reference standard, or as shown.

F. Manufacturers, or Equal
   1. Dresser, Style 38.
   2. Ford Meter Box Co., Inc., Style FC1 or FC3.
   3. Smith-Blair, Style 411.

4. Baker, Series 200

2.6 FLANGED END CONNECTORS

A. Flanged coupling adapters, shall be in accordance with AWWA C219.

B. Dismantling joints for connecting flanged pipe shall be AWWA C219 compliant. Provide studs and nuts to seal gasket separate and independent from tie-bar restraint system.

C. All dismantling joints shall be the restrained type per AWWA M-11. Tie-bar restraint system shall conform to ASTM A193-B7 per AWWA M-11 and be designed to withstand the test pressure shown on the Drawings.

D. All dismantling joints shall use standard flanges in accordance with AWWA C207. The thickness of the dismantling joint flanges shall be equal to or greater than the class of flange that is connected to as required by the test pressure as shown on the drawings. Buried flanges shall be wrapped with petroleum was tape per AWWA C217.

E. Manufacturers, or Equal
1. Smith-Blair, Style 972 or 975
2. Baker, Series DJ

2.7 FLEXIBLE CONNECTORS

A. Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment, and where shown. Flexible connectors for service temperatures up to 180 degrees F shall be flanged, reinforced Neoprene or Butyl spools, rated for a working pressure of 40 to 150 psi, or reinforced, flanged duck and rubber, as best suited for the application. Flexible connectors for service temperatures above 180 degrees F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for minimum 150 psi working pressure, unless otherwise shown. The connectors shall be 9 inches long, face-to-face flanges, unless otherwise shown. The final material selection shall be approved by the manufacturer. Submit manufacturer's shop drawings and calculations.

2.8 EXPANSION JOINTS

A. All piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement, without exertion of undue forces to equipment or structures. This may be accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints. Expansion joints shall be of stainless steel, monel, rubber, or other materials, best suited for each individual service. Submit detailed calculations and manufacturer's shop drawings, guaranteeing satisfactory performance of all proposed expansion joints, piping layouts showing all anchors and guides, and information on materials, temperature and pressure ratings.

2.9 PIPE THREADS

A. All pipe threads shall be in accordance with ANSI/ASME B1.20.1.

2.10 AIR AND GAS TRAPS

A. Air and gas pipes shall be sloping to low points, provided with drip legs, shutoff valves, strainers and traps. The traps shall be piped to the nearest drain. Air and gas traps shall be not less than 150-pound iron body float type with copper or stainless steel float. Bracket, lever, and pins shall be of stainless steel. Drain traps shall have threaded connections.

B. Manufacturers, or Equal
   1. Armstrong Machine Works.
   2. Spirax Sarco, Inc.

PART 3 - EXECUTION

3.1 GENERAL

A. All pipes, fittings, and appurtenances shall be installed in accordance with the requirements of the applicable Sections of Division 33. The lining manufacturer shall take full responsibility for the complete, final product and its application. All pipe ends and joints at screwed flanges shall be epoxy-coated, to assure continuous protection.

B. Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction to avoid damage to embedded raceways and rebars.

C. Flanges shall be installed at least 6-inches from a wall. Fittings shall be installed with sufficient clearance for maintenance and removal and reinstallation.

3.2 FIELD TESTING

A. All piping shall be tested in accordance with applicable standards and the contract documents.

END OF SECTION

SECTION 40 05 05
EXPOSED PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide all pipe and equipment insulation, complete and operable, in accordance with the Contract Documents. In addition to the insulation indicated, insulate any cold or hot piping and exhausts that could be hazardous to personnel upon contact.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Federal Specifications

HH-1-558B	Insulation Blocks, Boards, Blankets, Felts, Sleeving (Pipe and Tube Covering), and Pipe Fitting Covering, Thermal (Mineral Fiber, Industrial Type)

B. Commercial Standards

ASTM C 547	Specification for Mineral Fiber Preformed Pipe Insulation
ASTM E 84	Test Method for Surface Burning Characteristics of Building Materials

1.3 CONTRACTOR SUBMITTALS

A. Submit complete shop drawings of all thermal insulation, with manufacturer's data on materials, covering, jackets, and finish, in accordance with Section 01 33 20 – Contractor Submittals.

1.4 CLEANUP

A. After completion of all insulation, remove all debris from the site, clean all parts of the work to hand over the system in perfect condition.

PART 2 - PRODUCTS

2.1 GENERAL

A. All components of the insulation, including covering, mastics and adhesives shall have a flame-spread rating of not over 25, and a smoke development rating of not over 50. Ratings shall be as established by tests in accordance with ASTM E 84 and Federal Specification standards. The integrated insulation assemblies shall also conform to the above specifications. Insulation shall be applied in strict accordance with the manufacturer's instructions.

2.2 BASIC MATERIALS

A. Standard Insulation: This type of insulation shall be employed for process, cold-and hot water, steam, and condensate piping and equipment with surface temperatures up to 850 degrees F. Pipe insulation and jacketing shall be applied to piping where indicated, and shall include fittings, flanges and valves. Pipe insulation shall be molded-type pipe covering, made of fibrous glass with a minimum k-factor of 0.23 at 75 degrees F mean temperature. Unless otherwise indicated, the insulation thickness shall be as follows:

	Minimum Thickness of Insulation (Inches)
Pipe Insulation:	
Hot and cold water (domestic)-	
6 inches and smaller	1
Heat traced piping-	
3 inches and smaller	3
4 inches and larger	1 - 1/2
Equipment and Tanks:	
Heaters and manufactured equipment -	as recommended by manufacturer
Heat exchangers, tanks, and vessels-	3

B. Insulation for Heat Tracing: The insulation shall be oversized for installation over electric heating cable. Insulation shall have a factory-applied white fire-retardant vapor-barrier jacket of kraft paper and aluminum foil laminated together and reinforced with fiber glass yarn. Fittings and valves shall be covered with the same material as the pipe, cut in segments to fit snugly without open spaces, held in place with copper wire or cement, and then covered with the same jacketing material as the pipe. Insulated fittings adjacent to vapor-barrier insulation shall be sealed with an acceptable vapor-barrier cement before installation of the finish jacket. Pipe insulation and vapor-barrier shall be continuous through hangers and supports. Insulation shall be coordinated with the pipe hangers and supports and where insulation protection shields are provided the top half section of pipe insulation at support locations shall be of the same specified density, and the bottom half insulation segments provided between the pipe and the insulation protection shields shall have a density of not less than 6 lb/cu ft. All insulation shall be covered with smooth aluminum weatherproof metal or plastic preformed jacketing with a factory-attached moisture barrier. The jacket for the fittings shall consist of precision-formed smooth-sided sections and shall be sized to cover and protect the insulated fitting. Each section shall be manufactured from aluminum or PVC, and all joints shall be sealed with silicon mastic or solvent welding, to provide a continuous, air and weathertight joint. Strapping shall be 1/2-inch wide, Type 3003 aluminum or stainless steel.

C. Manufacturers, or Equal
1. Armstrong Contracting and Supply Corp.
2. Certain-Teed Corporation.

3. Manville.
4. Owens-Corning Fiber Glass Corp.
5. P.P.G. Industries, Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All insulation shall be installed by a qualified insulation contractor in strict accordance with the manufacturer's recommendations.

END OF SECTION

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SECTION 40 05 07
PIPE SUPPORTS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide pipe supports, seismic restraints, hangers, guides, and anchors, complete, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be in accordance with Section 01 33 20 - Submittal Procedures.

B. Shop Drawings: Shop drawings shall include the following information:
   1. Drawings of pipe supports, restraints, hangers, anchors, and guides
   2. Calculations for special supports and anchors.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Code Compliance: Piping systems and pipe connections to equipment shall be properly anchored and supported to prevent undue deflection, vibration, dislocation due to seismic events and line pressures, and stresses on piping, equipment, and structures. Supports and parts thereof shall conform to the requirements of ASME B31.1 – Power Piping, except as supplemented or modified below. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.

B. Structural Members: Wherever possible, pipes shall be supported from structural members. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided at no additional cost to the Owner. All supplementary members shall be in accordance with the requirements of the building code and the American Institute of Steel Construction and shall be acceptable to the Engineer.

C. Pipe Hangers: Pipe hangers shall be capable of supporting the pipe in all conditions of operation, allowing free expansion and contraction of the piping, and preventing excessive stress on equipment. Hangers shall have a means of vertical adjustment after erection. Hangers shall be designed to prevent becoming disengaged by any movement of the supported pipe. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves, shall include hydraulic shock suppressors. Hanger rods shall be subject to tensile loading only.

D. Hangers Subject to Horizontal Movements: At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement. Where horizontal pipe movement is greater than 1/2-inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold to the hot position of the pipe, the hanger

rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.

E. Spring-Type Hangers: Spring-type pipe hangers shall be provided for piping subject to vibration or vertical expansion and contraction, such as engine exhausts and similar piping. Spring-type hangers shall be sized to the manufacturer's printed recommendations and the loading conditions encountered. Variable spring supports shall be provided with means to limit misalignment, buckling, eccentric loading, or to prevent overstressing of the spring, and with means to indicate at all times the compression of the spring. Supports shall be capable of accommodating at least four times the maximum travel due to thermal expansion.

F. Thermal Expansion: Wherever expansion and contraction of piping is expected, a sufficient number of expansion loops or joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints permitting the piping to expand and contract freely in directions away from the anchored points. Components shall be structurally suitable to withstand loads imposed.

G. Heat Transmission: Supports, hangers, anchors, and guides shall be so designed and insulated, that excessive heat will not be transmitted to the structure or to other equipment.

H. Riser Supports: Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

I. Freestanding Piping: Free-standing pipe connections to equipment such as chemical feeders and pumps shall be firmly attached to steel frames fabricated from angles, channels, or I-beams anchored to the structure. Exterior, free-standing overhead piping shall be supported on fabricated pipe stands consisting of pipe columns anchored to concrete footings, with horizontal, welded steel angles and U-bolts or clamps securing the pipes.

J. Materials of Construction:
   1. General: Pipe support assemblies, including framing, hardware, and anchors, shall be steel construction, galvanized after fabrication, unless otherwise indicated.
   2. Submerged Supports: Submerged piping, as well as piping, conduits, and equipment in hydraulic structures within 24 inches of the water level, shall be supported with support, assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel, unless otherwise indicated.
   3. Corrosive: Piping in chemical and corrosive areas shall be supported with support assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel or FRP, unless otherwise indicated.

K. Point Loads: Any meters, valves, heavy equipment, and other point loads on PVC, FRP, and other plastic pipes, shall be supported on both sides, according to manufacturer's recommendations to avoid undue pipe stresses and failures. To avoid point loads, all supports on PVC, FRP, and other plastic piping shall be equipped with extra wide pipe saddles or galvanized steel shields.

L. Noise Reduction: To reduce transmission of noise in piping systems, copper tubes in buildings and structures shall be wrapped with a 2-inch wide strip of rubber fabric or similar, suitable material at each pipe support, bracket, clip, or hanger.

2.2 SUPPORT SPACING

A. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads. Pipe support spacing shall not exceed the maximum spans in the tables below. For temperatures other than ambient temperatures, or those listed, and for other piping materials or wall thicknesses, the pipe support spacings shall be modified in accordance with the pipe manufacturer's recommendations. Vertical supports shall be provided to prevent the pipe from being overstressed from the combination of all loading effects.

1. Support Spacing for Schedule 40 and Schedule 80 Steel Pipe

Nominal Pipe Diameter (inches)	Maximum Span (feet)
1/2	6
3/4 and 1	8
1 - 1/4 to 2	10
3	12
4	14
6	17
8 and 10	19
12 and 14	23
16 and 18	25
20 and Greater	30

2. Support Spacing for Welded Fabricated Steel Pipe

Maximum Spans for Pipe Supported in Minimum **120 degree** contact saddles (feet)

Nominal Pipe Diameter (inches)	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
24	33	37	41	43	45	47				
26	34	38	41	44	46	48				
28	34	38	41	44	47	49				
30	34	38	42	45	48	49				
32	34	39	42	45	48	50				
34	35	39	42	46	48	50				
36	35	39	43	46	49	51	55			
38	35	39	43	46	49	51	55			
40	35	40	43	47	49	52	56			
42	--	40	43	47	50	52	56			
45	--	40	44	47	50	53	57			
48	--	40	44	47	50	53	58	61		
51	--	41	44	48	51	53	58	62		
54	--	41	44	48	51	54	58	62		
57	--	41	44	48	51	54	59	63		
60	--	41	45	48	52	54	59	63	67	70
63	--	41	45	49	52	55	60	64	67	71
66	--	41	45	49	52	55	60	64	68	71
72	--	41	45	49	52	55	61	65	69	72

78	--	41	45	49	53	56	61	66	69	73
84	--	41	46	50	53	56	62	66	70	74
90	--	41	46	50	53	56	62	67	71	74
96	--	42	46	50	54	57	62	67	71	75

3. For steel pipe sizes not presented in this table, the support spacing shall be designed so that the stress on the pipe does not exceed 5,000 psi. Maximum deflection of pipe shall be limited to 1/360th of the span and shall be calculated by using the formula:

$$L = \sqrt{\frac{7500tD}{32t + D}}$$

Where: t = Thickness (inches)
D = Diameter (inches)
L = Maximum span (feet)

4. Support Spacing for Ductile-Iron Pipe:

Normal Pipe Diameter (inches)	Maximum Span (feet)
All diameters	Two supports per pipe length or 10 feet (one of the 2 supports located at joint)

5. Support Spacing for Copper Tubing:

Normal Pipe Diameter (inches)	Maximum Span (feet)
1/2 to 1 - 1/2	6
2 to 4	10
6 and greater	12

6. Support Spacing for Schedule 80 PVC Pipe:

Normal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
1/2	4
3/4	4.5
1	5
1 - 1/4	5.5
1 - 1/2	5.75
2	6.25
3	7.5
4	8.25
6	10
8	11
10	12.25
12	13.25

7. Support Spacing for Schedule 80 Polypropylene Pipe:

Normal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
1/2	3
3/4	3.5
1	3.75
1 - 1/4	4
1 - 1/2	4.25
2	4.5
3	5.5
4	6
6	7.25
8	8
10	8.75
12	9.5

8. Support Spacing for Fiberglass Reinforced Plastic (FRP) Pipe:

Normal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
2	8.8
3	10
4	11
6	12.7
8	13.4
10	14
12	15.4
14	16.2
16	17.3
16 and Greater	18

2.3 MANUFACTURED SUPPORTS

A. Stock Parts: Where not specifically indicated, designs which are generally accepted as exemplifying good engineering practice and use stock or production parts, shall be utilized wherever possible. Such parts shall be locally available, new, of best commercial quality, designed and rated for the intended purpose.

B. Manufacturers, or Equal
   1. Basic Engineers Inc., Pittsburgh, PA.
   2. Bergen-Paterson Pipesupport Corp., Woburn, MA.
   3. Grinnell Corp. (Supply Sales Company), Cranston, RI
   4. NPS Products, Inc., Westborough, MA.
   5. Power Piping Company, Pittsburgh, PA.

2.4 COATING

A. Galvanizing: Unless otherwise indicated, fabricated pipe supports other than stainless steel or non-ferrous supports shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM A 123 - Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

B. Other Coatings: Other than stainless steel or non-ferrous supports, all supports shall receive protective coatings in accordance with the requirements of Section 09 90 01 - Protective Coatings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Pipe supports, seismic restraints, hangers, brackets, anchors, guides, and inserts shall be fabricated and installed in accordance with the manufacturer's printed instructions and ASME B31.1 - Power Piping. Concrete inserts for pipe hangers and supports shall be coordinated with the form work.

B. Appearance: Pipe supports and hangers shall be positioned to produce an orderly, neat piping system. Hanger rods shall be vertical, without offsets. Hangers shall be adjusted to line up groups of pipes at the proper grade for drainage and venting, as close to ceilings or roofs as possible, without interference with other work.

3.2 FABRICATION

A. Quality Control: Pipe hangers, supports, and seismic restraints shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available. Fabricated supports shall be neat in appearance without sharp corners, burrs, and edges.

END OF SECTION

SECTION 40 05 10
MILL PIPING – EXPOSED AND BURIED

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall furnish and install all exposed and buried mill piping (pipe diameter 6 inches and less) as shown and in accordance with Contract Documents. This section applies to all mechanical Work and associated piping systems. Work related specifically to plumbing piping systems shall be performed in accordance with Division 23.

B. All work shall be in strict accordance with the International Plumbing Code, and codes of the State of Utah, City of Riverton, and any other authorities having jurisdiction. The Contractor shall have required certifications and be thoroughly familiar with the local codes. The Contractor shall obtain and pay for all necessary permits.

C. This section outlines requirements the following small (pipe diameter 6 inches and less) mechanical piping and associated accessories:
   1. Small steel pipe
   2. Solvent welded PVC pipe and Valves
   3. CPVC pipe and Valves
   4. PVDF pipe

D. The Contractor shall furnish hoses, hose racks and signage where indicated on the Drawings and as indicated herein.

1.2 REFERENCE STANDARDS

A. Commercial Standards

ANSI/ASME B16.3	Malleable Iron Threaded Fittings
ANSI/ASME B16.4	Gray Iron Threaded Fittings,
ASMEB16.5	Pipe Flanges and Flanged Fittings,
ANSI B16.11	Forged Steel Fittings, Socket-Welding and Threaded
ANSI B16.12	Cast-Iron Threaded Drainage Fittings
ANSI/ASME B16.15	Cast Bronze Threaded Fittings, Classes 125 and 250
ANSI B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ANSI B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASTM A 53	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 74	Specification for Cast Iron Soil Pipe and Fittings
ASTM A 105	Specification for Carbon Steel, Forgings for Piping Applications
ASTM A 106	Specification for Seamless Carbon Steel Pipe for High Temperature Service
ASTM A 312	Specification for Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A 518	Specification for Corrosion-Resistant High-Silicon Iron Castings
ASTM B 43	Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B 62	Specification for Composition Bronze or Ounce Metal Castings
ASTM B 88	Specifications for Seamless Copper Water Tube
ASTM C 599	Specification for Conical Process Glass Pipe and Fittings.
ASTM D 1785	Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2996	Specification for Filament-Wound Reinforced Thermosetting Resin Pipe
ASTM D 3222	Specification for Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding, Extrusion, and Coating Materials
ASTM D 4101	Specification for Propylene Plastic Injection and Extrusion Materials
ASTM F 441	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

B. Chlorine Institute Pamphlet 6 Piping Systems for Dry Chlorine

1.3 CONTRACTOR SUBMITTALS

A. For the materials and equipment items supplied under the provisions of this Section, submit copies of the manufacturer's product specifications and performance details according to the requirements of Section 01 33 20 - Contractor Submittals.

B. Product information for all valves shall be submitted in accordance with Section 40 05 51 – Valves, General.

PART 2 - PRODUCTS

2.1 SMALL STEEL PIPE (SYSTEMS 1, 2, 3 AND 6)

A. Unless otherwise indicated, galvanized steel pipe and black steel pipe in sizes 6 inches in diameter and smaller shall conform to the requirements of ASTM A 53 or ASTM A 106, as called out in the piping schedule and shall be Schedule 40 or 80 as indicated. Galvanized steel pipe shall not be cement mortar lined unless otherwise indicated. Fittings for galvanized steel pipe shall be of galvanized malleable iron, with NPT or grooved ends. Black pipe may have welded joints, with standard or extra strong welding fittings, or fittings indicated. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
2. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
3. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1. Unions shall be as manufactured by Henry Valve Company; Vogt Valve Co.; or equal.
5. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
6. Joint Compound and Tape: Suitable for natural gas.
7. Steel Flanges and Flanged Fittings: ASME B16.5.
8. Gasket Material: Thickness, material, and type suitable for natural gas.

2.2 COPPER TUBING (SYSTEM 24)

A. Hard Copper Tube and Fittings: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.

1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.
3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
5. Copper Pressure-Seal-Joint Fittings:
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Elkhart Products Corporation; Industrial Division; NIBCO INC.; Viega; Plumbing and Heating Systems.
    b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
    c. NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.
6. Copper Push-on-Joint Fittings:
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        1) NVent LLC.
    b. Description: Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22; with stainless-steel teeth and EPDM-rubber O-ring seal in each end instead of solder-joint ends.

B. Soft Copper Tube and Fittings: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
   1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   2. Copper Pressure-Seal-Joint Fittings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Elkhart Products Corporation; Industrial Division; NIBCO INC.; Viega; Plumbing and Heating Systems.
      b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
      c. NPS 3 and NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

2.3 CPVC (CHLORINATED POLYVINYL CHLORIDE) PRESSURE PIPE, SOLVENT-WELDED (SYSTEM 17)

A. CPVC system and components shall conform to the requirements of Section 33 05 19 – Pressure Piping Tied Joint Restraint System.

B. Solvent Cements for Joining CPVC Piping and Tubing shall conform to ASTM F 493 and the requirements of Section 33 05 19 – Pressure Piping Tied Joint Restraint System.

C. CPVC Ball Valves shall conform to Section 40 05 63 – Ball Valves.

D. CPVC Ball-Check and Swing-Check Valves shall comply with Section 40 05 65 – Valves for Pump Control and Check Service.

2.4 HOSE BIBBS AND HYDRANTS

A. All hose bibbs and hydrants in exposed locations subject to freezing shall be the non-freeze type. Hose bibbs connected to a non-potable water supply shall be provided with plastic or stainless-steel warning signs "DO NOT DRINK," in clearly legible letters, and permanently attached at the hose bibb. Hose bibbs shall be provided with vacuum breakers as furnished by Crane Co., American Standard, or equal.

B. Manufacturers, or Equal:

Dwg. Callout	Fixture Type	Description
HB-1	Non-freeze Post-type	Exposed bronze hydrant, post-type, depth of bury to suit local conditions; minimum 4 feet. 1. Woodward Mfg. Co., Model Iowa Y1
WH	Non-freeze wall-type	Heavy duty bronze hydrant with nickel-bronze face, hinged cover, recessed box, and key. Length to suit wall. 1. Josam Mfg. Co., Series 71000 2. Jay R. Smith Mfg. Co., Fig. 5510/5511 3. Zurn Industries, Inc., Fig. Z-1300

HB	Hose valves	Heavy duty bronze hydrant, with composition disc, handwheel, cap and chain. Sizes 1 1/2-inch and 2 1/2 inch: 1. Fire-End and Croker Corp, Model 180 2. James Jones (Watts Regulator Co., Nos. J-383 and J-344, respectively Size 1-inch, without cap and chain: 1. Apollo (Conbraco Industries, Inc.), Model 70-805 2. Fire-End and Croker Corp, Model 180 Size 3/4-inch, without cap and chain: 1. Apollo (Conbraco Industries, Inc.) Model 70-804, or 78-104 2. Chicago Faucet No.7T 3. Ford Meter Box Co., Model B8H-233HB2 4. Woodford Manufacturing Co., Model Y24 or 24P
HB-4	Wall box type	Recessed, with nickel-bronze box, hinged cover, and key. 1. Josam Mfg. Co., Series 71020 2. Jay R. Smith Mfg. Co., Series 5710 3. Zurn Industries, Inc., Fig. Z-1345

2.5 SHOCK ABSORBERS

A. Install shock absorbers in accordance with Division 23.

2.6 ACCESS DOORS AND COVERS

A. Install access doors and covers in accordance with Division 23.

2.7 WALL-MOUNTED HOSE RACKS

A. The Contractor shall provide wall-mounted hose racks at locations indicated. Racks shall be all welded steel construction, of minimum 8-gage sheet steel, hot-dip galvanized after fabrication, and shall have a capacity to hold 100 feet of 3/4-inch or 1-1/2-inch hose. Where racks are located in the open, they shall be supported from two 2- by 2- by 1/4-inch galvanized steel angle posts set in a concrete base or as indicated.

2.8 HOSES AND NOZZLES

A. The Contractor shall furnish the following lengths of hose:
1. 4 - 50 ft lengths of 3/4-inch diameter hose
2. 2 - 50 ft lengths of 1-inch diameter hose
3. 4 - 75 ft lengths of 1-inch diameter hose

4. 2 – 100 ft lengths of 1-inch diameter hose

B. Each length of hose shall be provided with male and female connectors and nozzle. Hoses shall be seamless extruded rubber with dacron cotton exterior designed for a working pressure of at least 200 psi.

C. Nozzles shall be capable of complete shut-off and shall produce a solid straight stream and up to a 90-degree conical fog. Nozzle material shall be polished brass. Nozzles shall have rubber bumpers.

D. Nozzle Manufacturers, or Equal:
1. W.D. Allen Mfg. Co., Illinois
2. Fire-End and Crocker Corp., New York
3. Halprin Supply Co., Illinois
4. Western Fire Equipment Co., California

2.9 GASKETS AND BOLTS

A. Except as otherwise indicated, gaskets for flanged joints shall be in accordance with the requirements of Section 40 05 00 - Piping, General.

B. Except as otherwise indicated, bolts shall conform to the requirements of Section 05 50 00 – Metal Fabrications.

2.10 INSULATING CONNECTIONS

A. Insulating bushings, unions, couplings or flanges, as appropriate, shall be used for joining pipes of dissimilar metals, and for piping systems where corrosion control and cathodic protection are involved, in accordance with the requirements of Division 23.

2.11 PIPE INSULATION

A. Hot and cold liquid piping shall be installed in accordance with Division 23.

2.12 PIPE SUPPORTS

A. Pipe Supports, hangers, anchors, seismic restraints, and guides shall be in accordance with the requirements of Section 40 05 07 - Pipe Supports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Small Steel Pipe: Buried galvanized or black steel pipe shall be coated as specified in Section 09 90 01 – Protective Coatings or provided with an extruded high density polyethylene coating with minimum thickness of 35 mils.

B. Plastic Pipe: PVC, CPVC, and FRP pipe joints shall be solvent-welded in accordance with the manufacturer's instructions. Expansion joints or pipe bends shall be provided to absorb pipe

expansion over a temperature range of 100 degrees F, unless otherwise indicated. Care shall be taken to provide sufficient supports, anchors, and guides, to avoid stress on the piping. Obtain the services of the pipe manufacturer, to instruct the pipe fitters in the correct way of making solvent welded and threaded joints. Only clean, fresh primer and solvent shall be used at all times at the recommended temperatures.

C. Drain Traps: Drain traps shall be installed at low points in air and gas lines or elsewhere where indicated. Liquid outlets shall be piped to the nearest floor drain or open sump.

D. Couplings: Pipe couplings shall be installed in strict accordance with the manufacturer's printed recommendations, using the correct style coupling and gasket for any given application.

E. Gaskets for Flanged Joints: Gaskets shall be in accordance with the requirements of Section 40 05 00 - Piping, General.

F. Insulating Connections: All insulating connections shall be installed in accordance with manufacturer's printed instructions. Care shall be exercised to prevent damage to insulating fittings, while making up the joints.

3.2 CONTINUITY BONDS

A. Where required by the Contract Documents, all metallic pipe joints, except field-welded joints and insulating joints, shall be continuity bonded in accordance with the requirements of Section 40 05 00 - Piping, General.

END OF SECTION

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SECTION 40 05 23
STAINLESS STEEL PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide stainless steel pipe and appurtenances, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 40 05 00 – Piping, General apply to the Work of this Section.

1.2 DESIGN REQUIREMENTS

A. Piping Layout: Layout and fabricate piping systems with piping sections as long as possible, while still allowing shipment, so that joints made up in the field are minimized. Piping layout shall not rely on field welding, which is prohibited except as authorized by Engineer for special circumstances.
   1. Piping design indicated on the Drawings illustrates piping layout and configuration and does not indicate the location of every field joint and flexible coupling that may be needed to connect piping sections fabricated in the shop.
   2. Add joints and flexible couplings in a manner that achieves intent of maximizing size of individual piping sections.
   3. Obtain acceptance of Engineer for joints and connectors prior to fabrication.

B. Shop Fabrication: Fabricate piping sections in the shop and pickle and passivate at point of manufacture.

C. Field Assembly: Assemble shop-fabricated piping in the field using the joints designed into the piping layout or by using flexible couplings. Field welding is prohibited, unless written authorization is provided by the Engineer.

1.3 SUBMITTALS

A. Layout Drawings: Provide detailed layout drawings showing dimensions and alignment of pipes; location of valves, fittings, and appurtenances; location of field joints and couplings; location of pipe hangars and supports; connections to equipment or structures; location and details of shop welds; and thickness and dimensions of fittings and gaskets.
   1. Prepare layout drawings using latest version of AutoCAD.
   2. Submit AutoCAD files after layout drawings have been reviewed and accepted by Engineer.

B. Product Data: Provide the following:
   1. Photographs, drawings, and descriptions of pipe, fittings, welding procedures, and pickling and passivating procedures.
   2. Material specifications for pipe, gaskets, fittings, and couplings.
   3. Data on joint types and components used in the system including stub ends, backing flanges, flanged joints, grooved joint couplings and screwed joints.

C. Manufacturing certifications.

D. Welder and weld operator qualification certificates and welding procedures. A schedule of weld operators and identification symbols, as required in Article 2.01 F. Field welding references.

PART 2 - PRODUCTS

2.1 PIPE MATERIAL

A. General:
1. Pipe sizes specified in the Specifications and indicated on the Drawings are nominal.

B. Wall Thickness:
1. As specified in the piping schedule.

C. Piping Material and Manufacturing: Comply with the requirements outlined in the following table (unless otherwise specifically noted in the Drawings):

Service	Stainless Steel Grade	Pipe Manufacturing Process
Piping 3 inches in nominal diameter and larger	Type 304L stainless steel conforming to ASTM A 240	In accordance with ASTM A 778
Piping less than 3 inches in nominal diameter	Type 304L stainless steel conforming to ASTM A 240	In accordance with ASTM A 312

D. Fittings for Piping 3 inches in Nominal Diameter and Greater:
1. Material: ASTM A 240 stainless steel, grade to match the pipe.
2. Manufacturing Standard: ASTM A 774.
3. Wall Thickness of Fitting: In accordance with ANSI B 36.19 for the schedule of pipe specified.
4. End Configuration: As needed to comply with specified type of joint.
5. Dimensional Standards:
   a. Fittings with Weld Ends: In accordance with ANSI B 16.9.
   b. Fittings with Flanged Ends: In accordance with ANSI B16.5, Class 150.

E. Fittings for Piping Less than 3 inches in Diameter:
1. Material: ASTM A 240 stainless steel, grade to match the pipe.
2. Manufacturing Standard: ASTM A 403, Class WP.
3. Wall Thickness and Dimensions of Fitting: In accordance with ANSI B16.3 or ANSI B16.9 as appropriate and as required for the schedule of pipe specified.
4. End Configuration: As needed to comply with specified type of joint.
5. Forgings conforming to ASTM A182, Grade F304 or Grade F316; or barstock conforming to ASTM A276, Type 304 or Type 316. Forging or barstock material shall match the piping materials.

F. Piping Joints:
1. Joint Types, Piping Greater than 2 Inches in Diameter, General:
   a. Where type of joint is specifically indicated on the Drawings or specified, design and shop-fabricate piping sections utilizing type of joint illustrated or scheduled.

b. Where type of joint is not specifically indicated on the Drawings or specified in the Piping Schedule, design and shop-fabricate piping sections utilizing any of the following joint types:
   1) Piping stub ends with backing flanges.
   2) Welded joints.
   3) Flanged joints.

c. Joints at Valves and Pipe Appurtenances: Provide flanged valves and flanged pipe appurtenances in stainless steel piping systems with flanged ends. Design and fabricate piping sections to make connections with flanged valves and pipe appurtenances using piping stub ends with backing flanges, flanged coupling adapters or flanged joints.
   1) Flexible Couplings and Flanged Coupling Adapters: Provide stainless steel construction with materials matching the piping system, Dresser Industries, Style 38 or equal.

2. Joints in Piping 2 Inches in Diameter and Smaller: Flanged or screwed with Teflon tape thread lubricant.
3. Welded Joints:
   a. Pipe 12 Inches and Larger in Diameter: Automatically weld joints using gas tungsten-arc procedures.
   b. Piping 4 Inches Through 12 Inches in Diameter: Double butt welded joints
   c. Piping less than 4 Inches in Diameter: Single butt-welded joints.
4. Flanged Joints: Conforming to the requirements of ANSI B16.5, Class 150.
5. Piping Stub Ends and Backing Flanges for Pipe 3 inches and Larger:
   a. Piping Stub Ends: Cast Type 304L or 316L stainless steel to match the pipe material with machined gasket and wetted surfaces of stub ends free of crevices, pits, cracks and protrusions. Manufacturers: Alaskan Copper Works, Figure SK-38 or equal.
   b. Backing Flanges: Cast or forged Type 304 stainless steel with drilled bolt patterns conforming to ANSI B16.1, Class 125 or ANSI B16.5, Class 150. Manufacturers: Alaskan Copper Works, Figure SK-39 or equal.
6. Flanges for Schedule 10s, 40s and 80S Pipe:
   a. Provide forged Type 316L stainless steel welding neck flanges or slip-on flanges conforming to ANSI B16.5 Class 150.
   b. Material shall conform to ASTM A182.
7. Grooved Joints: Rigid type with rolled grooves.
   a. Pipe and fittings roll grooved to conform with AWWA C 220.
   b. Grooving may be accomplished in factory or in field.
   c. Couplings: Rigid type, cast from ductile iron, Victaulic Style 07 or equal. Coat per Section 09 90 01 – Protective Coatings.

G. Gaskets:
1. Aeration Air Service: EPDM, suitable for temperatures up to 250 °F, 1/8-inch thick (minimum), 60 shore hardness, smooth surface. Garlock Style 8314 or equal.
2. All Other Service Applications: EPDM, nitrile, or other materials compatible with the process fluid.

H. Bolts for Flanges and Stub End/Backing Flanges: In compliance with ASTM A193 heavy hex head. Length such that after installation, end of bolt projects 1/8-inch to 3/8-inch beyond

outer face of nut. Nuts shall comply with ASTM A194 heavy hex pattern. Bolts, nuts, and washers shall be Type 316 stainless steel.

I. Fabrication of Pipe Sections:
   1. Welding: Weld in accordance with Section 05 50 00 – Metal Fabrications using electrodes and techniques in accordance with AWS D10.4.
   2. Weld Seams:
      a. Full penetration welds, free of oxidation, crevices, pits and cracks and without undercuts.
      b. Provide weld crowns of 1/16 inch with tolerance of plus 1/16 inch and minus 1/32 inch.
      c. Where internal weld seams are not accessible, use gas tungsten-arc procedures with internal gas purge.
      d. Where internal weld seams are accessible, weld seams inside and outside using manual shielded metal-arc procedures.

J. Pickling and Passivation:
   1. Following shop fabrication of pipe sections, straight spools, fittings and other piping components, pickle and passivate fabricated pieces.
   2. Immerse fabricated pieces in sulfuric acid solution followed by immersion in a nitric-hydrofluoric bath and subsequent wash at the proper temperature and length of time.
   3. Finish Requirements: Remove free iron, heat tint oxides, weld scale, and other impurities, and obtain a passive finished surface.

2.2 STAINLESS STEEL TUBING

A. Stainless Steel Tubing: Seamless tubing made of Type 316L stainless steel and conforming to ASTM A 269, wall thickness not less than 0.065 inches.

B. Fittings: Swage ferrule design with components made of Type 316 stainless steel.
   1. Double acting ferrule design, providing both a primary seal and a secondary bearing force.
   2. Flare, bite, or compression type fittings are not acceptable.
   3. Manufacturers: One of the following or equal:
      a. Crawford Fitting Company, Swagelok.
      b. Hoke, Gyrolok.
      c. Parker, CPI.

C. Valves for Use with Stainless Steel Tubing:
   1. Ball type valves with swage ends to match tubing diameter.
   2. Type 316 / 316L stainless steel with TFE seats.
   3. Manufacturers: Nupro or equal.

2.3 SOURCE QUALITY CONTROL

A. Visually inspect pipe for welding defects such as crevices, pits, cracks, protrusions, and oxidation deposits.

B. Provide written certification that the pipe as supplied conforms to the requirements of ASTM A778. Supplemental testing is not required.

C. Provide written certification that the fittings as supplied conform to the requirements of ASTM A774. Supplementary testing is not required.

PART 3 - – EXECUTION

3.1 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true. Ends of threaded pipes shall be reamed and filed smooth. Pipe fittings shall be equally cleaned before assembly.

3.2 INSTALLATION

A. General: Stainless steel pipe shall be installed in a neat and workmanlike manner, properly aligned and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipe shall afford maximum headroom and access to equipment, and where necessary all piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. Installation shall be acceptable to the Engineer.

B. Supports and Anchors: Piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 40 05 07 – Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipe shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences.

C. Valves and Unions: Unless otherwise indicated, connections to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

D. Protection: Preserve appearance and finish of stainless steel piping by providing suitable protection during handling and installation and until final acceptance of the Work.
   1. Handling methods and equipment used shall prevent damage to the coating and shall include the use of wide canvas slings and wide padded skids.
   2. Bare cables, chains, hooks, metal bars, or narrow skids shall not be used.

3.3 PIPE JOINTS

A. Threaded Joints: Pipe threads shall conform to ANSI/ASME B 1.20.1 – Pipe Threads, General Purpose (inch), and shall be full and cleanly cut with sharp dies. Not more than three threads shall remain exposed after installation.

B. Welded Joints: Welded joints shall conform to the specifications and recommendations of ANSI/ASME B 31.1 – Power Piping. Welding shall be done by skilled and qualified welders per Section 40 05 00 – Piping, General.
   1. Field welding is prohibited unless written authorization is provided. Pipe butt welds may be performed at the Site, if authorized by the Engineer, providing the butt welds

are performed only with an inert gas shielded process and that other indicated welding requirements are followed rigidly.

2. Residue, oxide, and heat stain shall be removed from any type of field weld and the affected areas adjacent by the use of stainless steel wire brushes, followed by cleaning, inside and outside of pipe, with an agent such as Eutectic Company's "Euclean" or equal, followed by complete removal of the agent.

C. Grooved Joints: Grooves for grooved couplings and fittings shall be made with specially designed grooving tools to the manufacturer's recommendations and conforming to ANSI/AWWA C606. Grooves shall be clean and sharp without flaws, and the pipe ends shall be accurately cut at 90 degrees to the pipe axis.

3.4 INSPECTION AND FIELD TESTING

A. Inspection: The finished installation shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Damage shall be repaired to the satisfaction of the Engineer.

B. Field Testing: Prior to enclosure or burying, piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour, without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The Contractor shall furnish all test equipment, labor, materials, and devices at no extra cost to the Owner. [For additional testing requirements refer to Section 33 13 00 – Water Pipeline Testing and Disinfection.]

1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.
2. Leaks shall be repaired to the satisfaction of the Engineer and the system shall be re-tested until no leaks are found.

END OF SECTION

SECTION 40 05 50
MISCELLANEOUS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 - Valves, General, apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51.

PART 2 - PRODUCTS

2.1 AIR-VACUUM AND AIR-RELEASE VALVES

A. Air and Vacuum Valves: Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled, and allowing air to re-enter while pipelines are being drained. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise indicated.

B. Air-Release Valves: Air-release valves shall vent accumulating air while system is in service under pressure and be of the size indicated. Valves shall meet the same general requirements as indicated for air and vacuum valves except that the vacuum feature will not be required. Valves shall be designed for a minimum water-working pressure of 150 psi, unless otherwise indicated.

C. Combination Air Valves: Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. Valves shall have the same general requirements as indicated for air and vacuum valves.

D. Manufacturers, or Equal
   1. APCO (Valve and Primer Corporation)
   2. Crispin - Multiplex Manufacturing Company
   3. GA Industries
   4. Val-Matic (Valve and Manufacturing Corporation)

2.2 AIR AND VACUUM VALVES FOR VERTICAL TURBINE AND SUBMERSIBLE TURBINE PUMPS

A. An air and vacuum valve for the vertical turbine pump shall be installed on the pump discharge pipe indicated. The valve shall vent large quantities of air out through the orifice when pump starts, close tight when liquid enters, and permit large quantities of air to re-enter through orifice when pump stops, to prevent vacuum forming in the pump column. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. The discharge orifice shall be fitted with a double-acting throttling device to regulate and restrict air venting, which shall establish a pressure loading on the rising column of water and eliminate damaging shock to the pump, controls, and valves during pump start. On pump stop, a double-acting throttling device shall automatically open, allowing full line unrestricted air re-entry to prevent any vacuum from forming in the pump column. The valve shall be designed for minimum 150 psig water-working pressure.

B. Manufacturer or Equal
   1. APCO (Valve and Primer Corporation)
   2. Val-Matic (Valve and Manufacturing Corporation)

2.3 VACUUM RELIEF/AIR INLET VALVE FOR SURGE TANK

A. A vacuum relief/air inlet valve shall be installed on the surge tank. The vacuum relief/air inlet valve shall be normally closed, capable of admitting large quantities of air into the system immediately should the system pressure become negative and preventing a vacuum from forming during draining, pipeline rupture, or water column separation. The valve shall be of the size indicated, with flanged ends to match piping connections. Bodies shall be of high-strength cast iron with a steel hood. The float, seat, spring, and moving parts shall be constructed of Type 316 stainless steel. The internal valve-plug and seat shall be heavy cast brass. The plug shall be normally closed by means of a stainless steel spring and shall open when a vacuum/pressure differential exceeds 0.25 psig or less. Seat seal shall be of Buna-N providing a drip-tight seal. Valves shall be designed for minimum 150 psig water-working pressure, unless otherwise indicated.

B. Manufacturers, or Equal
   1. APCO (Valve and Primer Corporation)
   2. Val-Matic (Valve and Manufacturing Corporation)

2.4 BACKFLOW PREVENTER VALVES

A. General: Backflow preventers shall work on the reduced pressure principle. They shall consist of 2 spring-loaded check valves, automatic differential pressure relief valve, drain valves, and shut-off valves. The body material shall be bronze or cast iron for a working pressure of not less than 150 psi, with bronze or stainless steel trim. Drain lines with air gaps shall be provided. The backflow preventer valves shall be in accordance with AWWA C511 standard.

B. The number and sizes of backflow preventors required are given on the Contract Drawing P&IDs.

C. Manufacturers, or Equal
   1. Cla-Val Company
   2. Febco (CMB Industries)
   3. Hersey Products
   4. Watts, ACV
   5. Wilkins Regulator Division (Zurn Industries)

2.5 CORPORATION STOPS

A. Unless otherwise indicated, corporation stops shall be made of solid brass for key operation, with screwed ends with corporation thread or iron pipe thread, as required. Note that corporation stops on special chemical diffuser ports shall be 316 stainless steel – unless indicated otherwise.

B. Manufacturer, or Equal
   1. Ford Meter Box Company, Inc.
   2. James Jones Company (Watts, ACV)
   3. Mueller Company

2.6 MUD VALVES (NOT USED)

2.7 SOLENOID VALVES

A. Solenoid valves shall be of the size, type, and class indicated and shall be designed for not less than 150 psi water-working pressure. Valves for water, air, or gas service shall have brass or bronze body with screwed ends, stainless steel trim and spring, Teflon or other resilient seals with material best suited for the temperature and fluid handled. Unless otherwise indicated, for chemicals and corrosive fluids, solenoid valves with PVC, polyvinylidene fluoride (PVDF), or Teflon (PTFE) materials of construction, suitable for the specific application shall be provided. Enclosures shall be NEMA rated in accordance with the area designations of Section 26 00 00 – Electrical General Provisions. Coil ratings shall be for continuous duty. For electrical characteristics see the electrical Drawings or Specifications.

B. Manufacturers, or Equal
   1. For general duty
      a. Automatic Switch Co. (ASCO), Model RED HAT
      b. Skinner Valve (Parker Hannifin Corporation)
      c. Magnatrol Valve Corporation
      d. J. D. Gould Co.
   2. Metallic valves for corrosive fluids
      a. Valcor Engineering Corporation
   3. Plastic valves for corrosive fluids
      a. +GF+ Plastic Systems, Inc.
      b. Spears Mfg. Co.

2.8 FLANGED PRESSURE RELIEF VALVES, SIZES 1-1/2 INCHES THROUGH 42 INCHES

A. Valve Characteristics: The pressure relief valve shall open when the inlet pressure exceeds a set maximum level. It shall maintain that level and gradually close as the inlet pressure drops below the maximum pressure. The valve shall be a hydraulically operated, adjustable, pilot

controlled, diaphragm type globe or angle valve as indicated. All necessary repairs shall be possible without removing the valve from the pipeline.

B. Valve Body: The valve body shall be of cast iron, ASTM A 48 – Gray Iron Castings, or ASTM A 126 – Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with 125 lb or 250 lb flanged ends to ANSI/ASME B 16.1 – Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, or the body shall be of ductile iron to ASTM A 536 – Ductile Iron Castings, with 150 lb or 300 lb flanged ends to ANSI/ASME B 16.42 - Ductile Iron Pipe Flanges and Flanged Fittings. The valve cover shall be flanged and be of the same material as the body. Contractor is to select the appropriate valve pressure class as listed in the valve schedule and as recommended by the valve manufacturer to provide suitable operating service.

C. Valve Trim: The valve stems, springs, body seat rings, and all bolts, nuts, and washers shall be of Type 302, 303, or 316 stainless steel. The valve stems shall have top and bottom guides. All rubber parts shall be of Buna-N. The diaphragms shall be of Nylon-reinforced Buna-N, supported firmly between body and valve cover. The valve pistons and piston liners shall be bronze to ASTM B 62- Composition Bronze or Ounce Metal Castings.

D. Valve Controls: The valve shall be furnished with a complete, externally mounted control system, including adjustable speed control needle valves, strainer, and all necessary [copper or stainless steel] connecting tubing and fittings. The controls shall be capable of achieving all the flow and speed adjustment indicated.

E. Features: Where indicated in the Drawings, the relief valves shall be equipped with a limit switch to remotely detect valve position.

F. Factory Tests and Warranty: Valves shall be factory tested with a hydrostatic test and a functional test and a test certificate shall be submitted to the Engineer prior to delivery of valves. Valves shall be warranted for a period of 3 years from the date of shipment to be free of defects in materials and workmanship.

G. Spare Parts: The following spare parts shall be furnished in accordance with Section 40 05 51 (for each valve size):
   1. 1 set of all resilient seals, and discs
   2. 1 diaphragm (for diaphragm valves, only)

H. Manufacturers, or equal
   1. Singer Valve, Inc.
   2. Cla-Val Company
   3. Watts, ACV.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Backflow preventers shall be installed in utility water lines where required by applicable codes or regulations, and where indicated on Contract Drawings.

B. Valves shall be installed in accordance with the manufacturer's printed recommendations, and with Section 40 05 51.

C. Backflow preventers, as well as air and vacuum release valves, shall have piped outlets to the nearest acceptable drain, firmly-supported, and installed in such a way as to avoid splashing and wetting of floors and obstruction of traffic.

END OF SECTION

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SECTION 40 05 51
VALVES, GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide valves, actuators, and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 11 00 00 - Equipment General Provisions, apply to the Work of this Section.

C. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls indicated in other Sections of the Specifications.

D. Where a valve is to be supported by means other than the piping to which it is attached, the Contractor shall obtain from the valve manufacturer a design for support and foundation that satisfies the criteria in Section 11 00 00. The design, including drawings and calculations sealed by an engineer, shall be submitted with the Shop Drawings. When the design is approved, the support shall be provided.

E. Unit Responsibility: A single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve section. Unless indicated otherwise, the responsible manufacturer shall be the manufacturer of the valve.

F. Single Manufacturer: Where two or more valves of the same type and size are required, the valves shall be furnished by the same manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop Drawings: Shop Drawings shall contain the following information:
   1. Valve name, size, Cv factor, pressure rating, identification number (if any), and specification section number.
   2. Complete information on valve actuator, including size, manufacturer, model number, limit switches, and mounting.
   3. Cavitation limits for control valves.
   4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, handwheels, position indicators, limit switches, integral control systems, needle valves, and control systems.
   5. Complete wiring diagrams and control system schematics.
   6. Valve Labeling: A schedule of valves to be furnished with stainless steel tags, indicating in each case the valve location and the proposed wording for the label.

C. Technical Manual: The Technical Manual shall contain the required information for each valve.

D. Spare Parts List: A Spare Parts List shall contain the required information for each valve assembly, where indicated.

E. Factory Test Data: Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The data shall also include certification of quality and test results for factory-applied coatings.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. General: Valves and gates shall be new and of current manufacture. Shut-off valves 6-inches and larger shall have actuators with position indicators. Gate valves 18-inches and larger or where chain wheel is required, shall be furnished with spur gear and hand wheel. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 7-feet above working level shall be provided with chain actuators.

B. Valve Actuators: Unless otherwise indicated, valve actuators shall be in accordance with Section 40 05 52 - Valve and Gate Actuators.

C. Protective Coating: The exterior surfaces of all valves and the wet interior surfaces of ferrous valves of sizes 4-inches and larger shall be coated in accordance with Section 09 90 01 – Protective Coatings. The valve manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of valves shall not be epoxy coated.

D. Valve Labeling: Except when such requirement is waived by the construction manager in writing, a label shall be provided on shut-off valves and control valves except for hose bibbs and chlorine cylinder valves. The label shall be of 1/16-inch plastic or stainless steel, minimum 2-inches by 4-inches in size, as indicated in Section 41 05 02 - Piping Identification Systems, and shall be permanently attached to the valve or on the wall adjacent to the valve as directed by the construction manager.

E. Valve Testing: As a minimum, unless otherwise indicated or recommended by the reference Standards, valves 3-inches in diameter and smaller shall be tested in accordance with manufacturer's standard and 4-inches in diameter and larger shall be factory tested as follows:

1. Hydrostatic Testing: Valve bodies shall be subjected to internal hydrostatic pressure equivalent to twice the water rated pressure of the valve. Metallic valves rating pressures shall be at 100 degrees F and plastic valves shall be 73 degrees, or at higher temperature according to type of material. During the hydrostatic test, there shall be no leakage through the valve body, end joints, or shaft seals, nor shall any part of the valve be permanently deformed. The duration shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes.

2. Seat Testing: Valves shall be tested for leaks in the closed position with the pressure differential across the seat equal to the water rated pressure of the valve. The duration of test shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes. Leakage past the closed valve shall not exceed 1 fluid ounce per hour per inch diameter for metal seated valves and drop-tight for resilient seated valves.
3. Performance Testing: Valves shall be shop operated from fully closed to fully open position and reverse under no-flow conditions in order to demonstrate the valve assembly operates properly.

F. Certification: Prior to shipment, the Contractor shall submit for valves over 12-inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, or ASTM.

G. Valve Marking: Valve bodies shall be permanently marked in accordance with MSS SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.2 MATERIALS

A. General: Materials shall be suitable for the intended application. Materials in contact with potable water shall be listed as compliant with NSF Standard 61. Materials not indicated shall be high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. Unless otherwise indicated, valve and actuator bodies shall conform to the following requirements:
1. Cast Iron: Close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. Ductile Iron: ASTM A 536 - Ductile Iron Castings, or to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
3. Steel: ASTM A 216 - Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A 515 - Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service.
4. Bronze: ASTM B 62 - Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B 584 - Copper Alloy Sand Castings for General Applications.
5. Stainless Steel: Stainless steel valve and operator bodies and trim shall conform to ASTM A 351 - Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel.
6. PVC: Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454.
7. CPVC: Chlorinated Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 23447.
8. NSF Standard 14: Materials shall be listed for use in contact with potable water.

2.3 VALVE CONSTRUCTION

A. Bodies: Valve bodies shall be cast, molded (in the case of plastic valves), forged, or welded of the materials indicated, with smooth interior passages. Wall thicknesses shall be uniform in agreement with the applicable standards for each type of valve, without casting defects, pinholes, or other defects that could weaken the body. Welds on welded bodies shall be done

by certified welders and shall be ground smooth. Valve ends shall be as indicated, and be rated for the maximum temperature and pressure to which the valve will be subjected.

B. Valve End Connections: Unless otherwise indicated, valves 2-1/2 inches diameter and smaller may be provided with threaded end connections. Valves 3-inches and larger shall have flanged end connections.

C. Bonnets: Valve bonnets shall be clamped, screwed, or flanged to the body and shall be of the same material, temperature, and pressure rating as the body. The bonnets shall have provision for the stem seal with the necessary glands, packing nuts, or yokes.

D. Stems: Valve stems shall be of the materials indicated, or, if not indicated, of the best commercial material for the specific service, with adjustable stem packing, O-rings, Chevron V-type packing, or other suitable seal. Bronze valve stems shall conform to ASTM B 584, except that zinc content shall not exceed 16 percent.

E. Stem Guides: Stem guides shall be provided, spaced 10-feet on centers unless the manufacturer can demonstrate by calculation that a different spacing is acceptable. Submerged stem guides shall be 304 stainless steel.

F. Internal Parts: Internal parts and valve trim shall be as indicated for each individual valve. Where not indicated, valve trim shall be of Type 316 stainless steel or other best suited material.

G. Nuts and Bolts: Nuts and bolts on valve flanges and supports shall be in accordance with Section 05 50 00 – Metal Fabrications.

2.4 VALVE ACCESSORIES

A. Valves shall be furnished complete with the accessories required to provide a functional system.

2.5 SPARE PARTS

A. The Contractor shall furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. The Contractor shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. Spare parts are intended for use by the Owner, after expiration of the correction of defects period.

2.6 MANUFACTURERS

A. Manufacturer's Qualifications: Valve manufacturers shall have a successful record of not less than 5 years in the manufacture of the valves indicated.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. General: Valves, actuating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer's written instructions and as indicated. Gates shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe.

B. Access: Valves shall be installed with easy access for actuation, removal, and maintenance and to avoid interference between valve actuators and structural members, handrails, or other equipment.

C. Valve Accessories: Where combinations of valves, sensors, switches, and controls are indicated, the Contractor shall properly assemble and install such items so that systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on Shop Drawing submittals.

END OF SECTION

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SECTION 40 05 52
VALVE AND GATE ACTUATORS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide valve and gate actuators and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to valves and gates except where otherwise indicated in the Contract Documents.

C. Unit Responsibility: The valve or gate manufacturer shall be made responsible for coordination of design, assembly, testing, and installation of actuators on the valves and gates; however, the Contractor shall be responsible to the Owner for compliance of the valves, gates, and actuators with the Contract Documents.

D. Single Manufacturer: Where 2 or more valve or gate actuators of the same type or size are required, the actuators shall be produced by the same manufacturer.

E. The requirements of Section 26 00 00 - Electrical General Provisions apply to the Work of this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 20 - Submittal Procedures and Section 40 05 51 - Valves, General.

B. Shop Drawings: Shop Drawing information for actuators shall be submitted together with the valve and gate submittals as a complete package.

C. Calculations: Selection calculations showing dynamic seating and unseating torques versus output torque of actuator.

D. Technical Manuals: The Contractor shall furnish technical manuals for the butterfly valves, butterfly valve manual actuators, and butterfly valve electric motor actuators under one cover and in accordance with the requirements of Section 01 33 20 – Submittal Procedures.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, shut-off and throttling valves and externally actuated valves and gates shall be provided with manual or power actuators. The Contractor shall furnish actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. Actuators shall have the torque ratings equal to or greater than required for valve seating and dynamic torques,

whichever is greater, and shall be capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering. Actuator torque ratings for butterfly valves shall be determined in accordance with AWWA C504 - Rubber-Seated Butterfly Valves. Wires of motor-driven actuators shall be identified by unique numbers.

B. Manufacturers: Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate manufacturer. Where actuators are furnished by different manufacturers, the Contractor shall coordinate selection to have the fewest number of manufacturers possible.

C. Materials: Actuators shall be current models of the best commercial quality materials and be liberally-sized for the required torque. Materials shall be suitable for the environment in which the valve or gate is to be installed.

D. Actuator Mounting and Position Indicators: Actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and be of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counter-clockwise direction. Gear and power actuators shall be equipped with position indicators. Where possible, manual actuators shall be located between 48- and 60-inches above the floor or the permanent working platform.

E. Standard: Unless otherwise indicated and where applicable, actuators shall be in accordance with AWWA C 540 - Power-Actuating Devices for Valves and Slide Gates.

F. Functionality: Electric, pneumatic, and hydraulic actuators shall be coordinated with the power requirements of Division 26 and instrumentation equipment indicated in Division 40.

G. Fasteners: Fasteners shall be in accordance with Section 05 50 00 - Miscellaneous Metalwork.

H. Protective Coatings: Protective coatings shall be in accordance with Section 09 90 01 – Protective Coatings.

2.2 MANUAL ACTUATORS

A. General: Unless otherwise indicated, valves and gates shall be furnished with manual actuators. Valves in sizes up to and including 4-inches shall have direct acting lever or handwheel actuators of the manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the handwheel. Buried and submerged gear-assisted valves, gates, gear-assisted valves for pressures higher than 250 psi, valves 30-inches in diameter and larger, and where so indicated, shall have worm gear actuators, hermetically-sealed water-tight and grease-packed. Other valves 6-inches to 24-inches in diameter may have traveling nut actuators, worm gear actuators, spur or bevel gear actuators, as appropriate for each valve.

B. Buried Valves: Unless otherwise indicated, buried valves shall have extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys. Where so indicated, buried valves shall be in cast-iron, concrete, or similar valve boxes with covers of ample size to allow operation of the valve actuators. Covers of valve boxes shall be permanently labeled as required by the local

Utility Company or the Engineer. Wrench nuts shall comply with AWWA C 500 - Metal - Seated Gate Valves for Water Supply Service.

C. Chain Actuator: Manually-activated valves with the stem located more than 7-feet above the floor or operating level shall be provided with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains provided by the valve manufacturer. The wheel and guide shall be of ductile iron, cast iron, or steel, and the chain shall be hot-dip galvanized steel or stainless steel, extending to 5-feet 6-inches above the operating floor level. The valve stem of chain-actuated valves shall be extra strong to allow for the extra weight and chain pull. Hooks shall be provided for chain storage where chains interfere with pedestrian traffic.

D. Floor Stands: Valve actuator floor stands shall be cast iron or fabricated steel pedestals. The centerline of the actuator shall be approximately 42 to 48 inches above the base of the pedestal.

E. Floor Boxes: Hot dip galvanized cast iron or steel floor boxes and covers to fit the slab thickness shall be provided for operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.

F. Tee Wrenches: Buried valves with floor boxes shall be furnished with 2 operating keys or 1 key per 10 valves, whichever is greater. Tee wrenches sized so that the tee handle will be 2 to 4 feet above ground, shall fit the operating nuts.

G. Manual Worm Gear Actuator: The actuator shall consist of a single or double reduction gear unit contained in a weather-proof cast iron or steel body with cover and minimum 12-inch diameter handwheel. The actuator shall be capable of 90 degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing. The actuator shall consist of spur or helical gears or worm gearing. The gear ratio shall be self-locking to prevent "back-driving." The spur or helical gears shall be of hardened alloy steel and the worm gear shall be alloy bronze. The worm gear shaft and the handwheel shaft shall be of 17-4 PH or similar stainless steel. Gearing shall be accurately cut with hobbing machines. Ball or roller bearings shall be used throughout. Output shaft end shall be provided with spline to allow adjustable alignment. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator. Gearing shall be designed for a 100 percent overload. The entire gear assembly shall be sealed weatherproof. Manual worm gear actuators shall be Auma GS Series, Limitorque HBC Series, no “Or-Equals”.

H. Traveling-Nut Actuator: The actuator shall consist of a traveling-nut with screw (Scotch yoke) contained in a weatherproof cast iron or steel housing with spur gear and minimum 12-inch diameter handwheel. The screw shall run in 2 end bearings, and the actuator shall be self-locking to maintain the valve position under any flow condition. The screw and gear shall be of hardened alloy steel or stainless steel, and the nut and bushings shall be of alloy bronze. The bearings and gear shall be grease-lubricated by means of nipples. Gearing shall be designed for a 100 percent overload.

I. Schedule for Manual Actuator Types: For a complete schedule of manual actuators required on project valves (4” diameter and larger), see Contract Drawing GM-10 and GM-11.

2.3 ELECTRIC MOTOR ACTUATORS

A. General

1. Equipment Requirements: Where electric motor actuators are indicated, an electric motor-actuated valve control unit shall be attached to the actuating mechanism housing by means of a flanged motor adapter piece.
2. Gearing: The motor actuator shall include the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weather-proof NEMA 4 assembly. The actuator shall be a single or double reduction unit consisting of spur or helical gears and worm gearing. The spur or helical gears shall be of hardened alloy steel, and the worm gear shall be alloy bronze. Gearing shall be accurately cut with hobbing machines. Power gearing shall be grease- or oil-lubricated in a sealed housing. Ball or roller bearings shall be used throughout. Actuator output speed changes shall be mechanically possible by simply removing the motor and changing the exposed or helical gearset ratio without further disassembly of the actuator.
3. Starting Device: Except for modulating valves, the unit shall be so designed that a hammer blow is imparted to the stem nut when opening a closed valve or closing an open valve. The device should allow free movement at the stem nut before imparting the hammer blow. The actuator motor must attain full speed before stem load is encountered.
4. Switches
    a. Electronic Type Switches: Limit switches or valve position shall be sensed by a 15 bit, optical, absolute position encoder. The open and closed positions shall be stored in a permanent, non-volatile memory. The encoder shall measure valve position continuously, including both motor and hand wheel operation, with or without use of battery. An electronic torque sensor shall be furnished. The torque limit may be adjusted from 40 to 100 percent of rating in 1 percent increments. The motor shall be de-energized if the torque limit is exceeded. A boost function shall be included to prevent torque trip during initial valve unseating, and a “jammed valve” protection feature with automatic retry sequence shall be incorporated to de-energize the motor if no movement occurs. Valve actuators with electronic type switches shall be as manufactured by Limitorque or Auma Actuators, Inc.
    b. The actuator shall be wired in accordance with the schematic diagram. Wiring for external connections shall be connected to marked terminals. One of 1-inch and one of 1.25-inch conduit connection shall be provided in the enclosing case. A calibration tag shall be mounted near each switch correlating the dial setting to the unit output torque. Switches shall not be subject to breakage or slippages due to over-travel. Traveling-nuts, cams, or micro switch tripping mechanisms shall not be used. Limit switches shall be of the heavy-duty open contact type with rotary wiping action.
5. Handwheel Operation: A permanently attached handwheel shall be provided for emergency manual operation. The handwheel shall not rotate during electrical operation. The maximum torque required on the handwheel under the most adverse conditions shall not exceed 60 lb.ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lb. An arrow and either the word "open" or "close" shall be cast or permanently affixed on the handwheel to indicate the appropriate direction to turn the handwheel. A clutch lever shall be provided to put actuator into handwheel operation. Valves with electric motor actuators having stems more than

7-feet above the floor shall be provided with chain activator handwheels. The clutch lever shall be provided with a cable secured to the chain to allow disengagement for manual operation.

6. Motor: The motor shall be of the totally enclosed, non-ventilated, high-starting torque, low-starting current type for full voltage starting. It shall be suitable for operation on 480 volt, 3-phase 60 Hz current, and have Class F insulation and a motor frame with dimensions in accordance with the latest revised NEMA MG Standards. The observed temperature rise by thermometer shall not exceed 55 degrees C above an ambient temperature of 40 degrees C when operating continuously for 15 minutes under full rated load. With a line voltage ranging between 10 percent above to 10 percent below the rated voltage, the motor shall develop full rated torque continuously for 15 minutes without causing the thermal contact protective devices imbedded in the motor windings to trip or the starter overloads to drop-out. Bearings shall be of the ball type, and thrust bearings shall be provided where necessary. Bearings shall be provided with suitable seals to confine the lubricant and prevent the entrance of dirt and dust. Motor conduit connections shall be watertight. Motor construction shall incorporate the use of stator and rotor as independent components from the valve operation such that the failure of either item shall not require actuator disassembly or gearing replacement. . Two Class B thermal contacts or solid state thermistors imbedded within the motor windings shall be provided to protect against over-temperature damage. The motor shall be provided with a space heater suitable for operation on 120 volt, single phase, 60 Hz circuit unless the entire actuator is a hermetically sealed, non-breathing design with a separately sealed terminal compartment which prevents moisture intrusion. Each electric motor actuator shall be provided with a local disconnect switch or circuit breaker to isolate power from the motor and controller during maintenance activities.
7. Open/Close Operating Speed: Unless otherwise indicated, electric actuators shall provide a full close to full open or full open to full close operating time range from 30 to 60 seconds.
8. Schedule for Electric AC Actuator Type: For a complete schedule of electric actuators required on project valves (4" diameter and larger), see Contract Drawings GM-XX Equipment List.
    a. All electric actuators identified as "OPEN/CLOSE ELECTRIC" on Equipment List, shall have AC Reversing type actuators with an open to close and close to open speed times of 60 seconds and 60 seconds, respectively.
    b. All electric actuators identified as "MODULATING ELECTRIC" on Equipment List, shall have AC Modulating type actuators with an open to close and close to open speed times of 60 seconds and 60 seconds, respectively.
9. Remote Actuator Control Station. Valves with electric motor actuators where the valve centerline is located at a height greater than 6.5-feet above the floor shall provide a remote actuator control station at a location no higher than 4-feet above the floor. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications. The actuator controls shall be wall-mounted beneath the valve at a location approved by the Design Engineer.

B. Electric Motor Actuators (AC Reversing (Open / Close) Control Type)
1. General: Where indicated, electric motor actuators shall be the AC reversing type complete with local control station with open / stop / close and local/off/remote selector switches on the actuator local control station.

2. Actuator Appurtenances: The actuator for each valve shall be provided with a padlockable disconnect switch, open and closed status lights, open, close and lockout stop pushbuttons, a local/off/remote selector switch, and other devices indicated. The disconnect switches in certain applications are required to be located remotely from the actuator body itself, as shown on the Contract Drawings. The local control station may also be provided as an integral part of the actuator or remotely as otherwise indicated or required to permit operation by a person at floor elevation and within sight of the valve actuator. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications.
3. Starter: The starter shall be a suitably sized amperage rated reversing starter with its coils rated for operation on 480 volt, 3-phase, 60 Hz current. A control power transformer shall be included to provide a 120 volt source, unless otherwise indicated. The starter shall be equipped with 3 overload relays of the automatic reset type. Its control circuit shall be wired as indicated. The integral weatherproof compartment shall contain a suitably sized 120 volt ac, single phase, 60 Hz space heater to prevent moisture condensation on electrical components. A local power disconnect switch shall be provided with each actuator. A close-coupled, padlockable switch shall be provided with each actuator.
4. Local Control Station: Each actuator shall be provided with a local control station with the valve actuator assembly. The station shall include open, close, and stop push buttons, and a local/remote selector switch.
5. Manufacturers:
    a. Auma, SA Series (for valves 12 inches and smaller) or SA with GS worm gear (for valves 14 inches and larger).
    b. Limitorque, MX/QX Series
    c. Rotork, IQ3 Series
    d. No “Or-Equals” allowed.

C. Electric Motor Actuators (AC Modulating Control Type)
1. General: Where indicated, modulating electric motor actuators shall be the ac modulating type complete with a local control station with power disconnect switch or circuit breaker, provided with open/stop/close and local/off/remote selector switches on the actuator local control station, and open/close status lights.
2. Actuator Appurtenances: The actuator for each valve shall be provided with a padlockable disconnect switch, open and closed status lights, open, close and lockout stop pushbuttons, a local/off/remote selector switch, and other devices indicated. The disconnect switches in certain applications are required to be located remotely from the actuator body itself, as shown on the Contract Drawings. The local control station may also be provided as an integral part of the actuator or remotely as otherwise indicated or required to permit operation by a person at floor elevation and within sight of the valve actuator. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications.
3. Control Module: The control module shall be of the electronic solid-state ac type with control outputs for positioning the valve via 4 - 20 ma input signals.
4. Starter: The actuator shall control a solid-state reversing starter designed for minimum susceptibility to power line surges and spikes. The solid-state starter and control module shall be rated for continuous modulating applications. Power supply shall be 480 volt, 3 phase, 60 Hz. A disconnect switch shall be included with each actuator.

5. Construction: The control unit shall be microprocessor-based and shall contain an analog/digital converter, separate input-output switches, non-volatile random access memory for storage of calibration parameters and pushbutton calibration elements for field setup. Potentiometer adjustments shall contain a PID control function internally. In addition, the controller shall contain as standard feature a loss of command signal protection selectable to lock in last or lock in pre-set valve position and a valve position output signal in 4 - 20 ma. As an alternative to the construction requirement, the motor shall be capable of modulating at a rate of 600 starts per hour at the 50 percent to 85 percent travel range of the valve. The system shall allow control of the open, close, or percent open function when the local/off/remote switch is in the remote position. Each actuator shall have a frequency shut down system which when pre-programmed, shall function as directed upon receipt of an ESD signal.
6. Manufacturers:
    a. Auma, SA Series (for valves 12 inches and smaller) or SA with GS worm gear (for valves 14 inches and larger).
    b. Limitorque, MX/QX Series
    c. Rotork, IQ3 Series
    d. No "Or-Equals" allowed.

D. 120 VAC Quarter-Turn and Multiturn Electric Valve Operators on Isolation Valves 3-Inch Dia. and Smaller. Where indicated on Contract Drawings, and primarily on vendor supplied equipment skids and control packages, 120 VAC electric actuators may be supplied on smaller valves of 3-inch diameter and smaller, as follows:
1. Provide 120 VAC, 1-phase motor-operated valve operator suitable for use with quarter-turn ball valves, multiturn diaphragm valves, and multiturn globe valves. Operator shall have the following characteristics and features:
    a. Reversing capacitor-start motor rated for operation on 120 V ac, 60 Hz, single phase. Output torque as required for valve application and pressure differential.
    b. Integral motor overload protection, with auto reset
    c. Permanently-lubricated gear train
    d. For open/close control, provide four single pole, double throw cam actuated limit switches (2 OPEN, 2 CLOSED). One set of limit switches shall be used for both motor control and local indication. The other set shall be available for connection to remote monitoring. Limit switch contacts shall be adjustable and shall be rated for not less than 5 amps at 120 V ac.
    e. Local Control Station: Open/Close: Corrosion-resistant, NEMA 4X, for mounting near valve actuator. Provide 2 position selector switch for LOCAL-REMOTE selection and 2 pushbuttons, OPEN and CLOSE. In addition, provide OPEN and CLOSE indicating lights operating at 120 V ac for connection to valve control limit switches.
    f. For modulating control, provide an electronic positioner and feedback potentiometer. The positioner shall utilize a 4 - 20 ma signal to adjust the valve opening. Feedback potentiometer shall be 0 - 1000 ohms.
    g. Local Control Station Modulating: Corrosion resistant, NEMA 4X, for mounting near valve actuator. Provide 2 position selector switch for LOCAL-REMOTE selection, one OPEN and one CLOSE push buttons, a resistance to

current converter with 4 - 20 ma output, and a 0 to 100 percent electronic valve position indicator.

h. Local power disconnect switch (NEMA 4X) for disconnecting 120 V ac power to valve. Disconnect shall be installed in the field within sight of the valve actuator, in accordance with the requirements of NPFA 70.

2. See Drawings for control diagram wiring interface.
3. Two wire control systems are not required for this actuator.
4. Operators shall be RCS, Asahi/America Quarter Master or equal.

PART 3 - EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Field Adjustments: Field representatives of manufacturers of valves or gates with pneumatic, hydraulic, or electric actuators shall adjust actuator controls and limit-switches in the field for the required function.

3.2 INSTALLATION

A. Valve and gate actuators and accessories shall be installed in accordance with Section 40 05 51 - Valves, General. Actuators shall be located to be readily accessible for operation and maintenance without obstructing walkways. Actuators shall not be mounted where shock or vibrations will impair their operation, nor shall the support systems be attached to handrails, process piping, or mechanical equipment.

B. Inspection, Startup, and Field Adjustment: An authorized representative of the manufacturer shall visit the Site and witness the following:
1. Installation of the equipment for not less than two (2) Work Days
2. Inspection, checking, and adjusting the equipment for not less two (2) Work Days.
3. Startup and field-testing for proper operation for not less than two (2) Work Days.

C. Instruction of Owner's Personnel: The authorized service representative shall visit the Site for not less than 2 Days to instruct the Owner's personnel in the operation and maintenance of the equipment including step-by-step troubleshooting procedures with necessary test equipment.

END OF SECTION

SECTION 40 05 53
IDENTIFICATION FOR PROCESS PIPING

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide identification for all exposed piping and valves, in accordance with the requirements of the Contract Documents.

B. All piping identification work shall be coordinated with protective coatings and paint applied in accordance with Section 09 90 01 – Protective Coatings.

1.2 REFERENCE STANDARDS

A. Commercial Standards

ANSI A13.1	Scheme for the Identification of Piping Systems

1.3 CONTRACTOR SUBMITTALS

A. All submittals shall be in strict accordance with the requirements of Section 01 33 20 – Submittal Procedures and Section 40 05 00 – Piping, General.

B. Submit samples of all types of identification devices to be used in the Work.

C. Submit a list of suggested wording for all valve tags prior to fabrication.

PART 2 - PRODUCTS

2.1 IDENTIFICATION OF PIPING

A. Identification of all exposed pipe shall be accomplished in accordance with the OWNER's standard, and where no standard exists, in accordance with the following: by color-coding with bands and by lettering as specified in the Piping Color Schedule, herein provided, and in Section 09 90 01 – Protective Coatings.

B. Preprinted identification devices shall conform to the following:
   1. Identification labels shall bear the full piping system name as specified in the Piping Schedule shown.
   2. Install separate flow directional arrows with each label.
   3. Include black lettering on OSHA safety yellow self-adhesive vinyl or vinyl cloth.
   4. Lettering height: Meet ANSI A13.1.
   5. Label and Adhesive: Long lasting, resistant to moisture, oils, solvents, and weathering, meeting OSHA requirements.

6. Locate labels at all connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along the piping not greater than 18 feet on center, with at least one label applied to each exposed run of pipe.
7. Manufacturers or equal:
   a. Marking Services Inc., Milwaukee, WI
   b. W. H. Brady Co., Milwaukee, WI
   c. Seton Nameplate Corp., New Haven, CT

C. Piping Color Schedule: All piping and related valves and supports shall be painted/marked according to the Piping Color Schedule listed below.

Piping Color Schedule

ANSI Classification	ANSI Sub-Classification	Typical Project Piping	Pipe System Abbrev	Pipe Color	Letter Color
Materials Inherently Dangerous	Flammable or Explosive	Natural Gas	NG	Red	White
	Chemically Active or Toxic	Polymer Solution	PL	Orange w/ Green Band (markers)	Black
		Sodium Hypochlorite	SH	Yellow (markers)	Black
		Primary Coagulant	PC	Orange (markers)	Black
		Caustic Soda	CS	Yellow w/ Green Band (markers)	Black
Materials of Inherently Low Hazard	Gas	Process Air	PA	Federal Safety Purple	White
	Liquid or Liquid Admixture	Backwash Supply	BWS	Light Blue	Black
		Backwash Waste	BWW	Light Brown	Black
		Gravity Waste	GWW	Light Brown	Black
		Filter to Waste	FTW	Light Brown	Black
		Sedimentation Drain	SED	Dark Brown	Black
		Finished Water Effluent	FWE	Dark Blue	Black
		Raw Water Influent	RWI	Olive Green	Black
		Snowmaking Water	SNO	Olive Green w/ White Band	White
		Plant Water	PW	Dark Blue	White
		Raw Sewage	RS	Dark Gray	White
		Sanitary Drain	SD	Dark Grey	Black
		Culinary Water	CW	Dark Blue	White

1. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at all connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along the piping not greater than 9-ft on center, with identification labels applied to each exposed run of pipe as specified herein.

2.2 SMALLER DIAMETER PIPE

A. For all pipe 2-inches nominal diameter and smaller, provide and install snap-on markers that have one piece wrap around type constructed of pre-coiled acrylic plastic with clear polyester

coating, integral flow arrows, legend printed in alternating directions, 3/4 inch adhesive strip on inside edge, and 360 degree visibility.

2.3 IDENTIFICATION OF VALVES AND SHORT PIPE LENGTHS

A. Identifying devices for valves and the sections of pipe that are too short to be identified with color bands, lettered labels, and arrows shall be identified with metal or plastic tags.

B. Provide metal tags made of stainless steel with deep stamped and black-filled lettering. Plastic tags shall be solid black plastic laminate with white embossed letters. Tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to such valves or short pipes using two stainless steel bolts or screws.

C. Lettering. Provide ¼-inch high valve service abbreviated lettering on one line over ½-inch high valve service chart number. Wording on the valve tags shall describe the function of each valve (e.g., "HWR-BALANCING," "CLS THROTTLING," "PUMP SHUT-OFF").

PART 3 - EXECUTION

3.1 GENERAL

A. All labels and identification tags shall be installed in accordance with the manufacturer's printed instructions, and shall be neat and uniform in appearance. All such tags or labels shall be readily visible from all normal working locations.

3.2 PIPE IDENTIFICATION

A. Each pipe shall be identified at intervals of 18 feet, and at least one time in each room. Piping shall also be identified at a point approximately within 2 feet of all turns, ells, valves, and on the upstream side of all distribution fittings or branches. Sections of pipe that are too short to be identified with color bands, lettered labels, and directional arrows shall be tagged and identified similar to valves.

B. Pipe identification shall consist of 4 elements, i.e., 2 color bands, a lettered label, and a directional label. The bands shall be arranged so that the lettered label and the directional arrow are placed between the 2 bands.

END OF SECTION

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SECTION 40 05 56
PLUNGER VALVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish horizontal in-line 18 inch ANSI 150 class Plunger Valve complete with electric motor actuator for modulating service for independent flow control or independent pressure control via a 4-20 mA signal from a PLC and PI(D) loop system integrated with output from a pressure transmitter or flow meter. Control of pressure or flow shall be independent. The PLC shall send an alarm if either the pressure or flow setpoints are not maintained. Flow and pressure outputs shall additionally be sent to SCADA for remote site verification.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 05 57 – Valve Actuators

B. Section 09 90 00 – Protective Coatings

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American National Standards Institute (ANSI)

B1.20.1	Pipe Threads, General Purpose (Inch)
B16.1	Cast Iron Pipe Flanges and Flanged Fittings
B16.5	Steel Pipe Flanges and Flanged Fittings

B. American Society for Testing and Materials (ASTM)

A48	Specification for Gray Iron Castings
A216	Specification for Steel Castings, Alloy, Specially Heat-Treated, for Pressure-Containing Parts, Suitable for High-Temperature Service.
A536	Specification for Common Requirements for Iron Castings for General Industrial Use.
A743	Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application

C. American Iron and Steel Institute (AISI)

AISI 304	Austenitic Stainless Steel (maximum percent: 0.08C, 2.0 Mn, 1.0 Si, 18-20 Cr, 8-10.5 Ni)
AISI 420	Martensitic Stainless Steel (minimum percent: 0.15C, maximum percent: 1.0 Mn, 1.0 Si, 12-14 Cr, 0.0 Ni,)

D. European (EN or DIN) standards equivalent to referenced American standards; subject to Engineer approval.

E. Purchaser Furnished Data:
Operating Conditions, design criteria, process criteria, and facility drawings shall be provided to allow the manufacturer to properly design customize Plunger Valve performance.

1.4 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00 Submittal Procedures, and as indicated herein.

B. Submit Manufacturer's data and descriptive literature written in the English language and in US Imperial units. Include catalog data, preliminary performance testing procedures, quality control procedures, calculations, detailed construction sheets showing all valve parts and descriptions of materials of construction with and applicable to USA material specifications, such as AISI, ANSI, ASTM, AWWA, American Society of Automotive Engineers (SAE) or the Copper Development Association (CDA). Identify each valve by tag number to which the catalog data and detail sheets pertain.

C. Furnish for approval prior to release to manufacture, factory developed production drawings that clearly show in US imperial units, valve dimensions, laying lengths, port sizes, component parts and materials of construction. Provide graphical factory generated computer modeling results for both estimated noise levels in decibels and for cavitation and its' control through the complete stroke of the valve and through all flow rates.

D. Furnish for approval prior to release to manufacture, shop assembly drawings that clearly show dimensions and orientation of valve actuators as installed on the valves. Provide valve actuator safety verification through the complete stroke specifically noting values for both break torque under maximum differential as well as maximum dynamic torque. Use the ratio of actuator output torque over valve input torque for validation. Valve Manufacturers compliance shall be factory signed and dated.

E. Furnish for approval prior to release to manufacture, all shop coating and lining.

F. During manufacture, furnish 6 copies of signed and dated valve manufacturers mil thickness and holiday free coating and lining test reports. Describe test results and repair procedures for each valve. Do not ship valves to project site until the reports have been approved by the Engineer and accepted by the Owner.

G. Prior to shipping, furnish for approval six signed and dated copies of valve manufacturer's factory shop hydrostatic test reports, performance test reports and any other required test reports. Test reports shall show all relevant test parameters of the valve and actuator assembly as tested in the Manufacturer's facility and shall indicate valve orientation, flow rate, and inlet/outlet pressures as a minimum.

H. Factory export packaging specifications shall be submitted for approval with quotation. Factory export packaging specifications shall be applicable to overseas shipping via surface carrier.

I. Submit current quality assurance program certificate of compliance with proposal.

1.5 SUBSTITUTION

A. Where Plunger Valves are shown or specified in project specifications or plans issued by the Owner, no Contractor may substitute any other style of valve that has not been specifically approved by the Owner at least 2 weeks prior to bid.

1.6 QUALITY ASSURANCE

A. The Manufacturer shall be ISO 9001 and ISO 14001 Certified. Plunger Valve shall be NSF 61 & 372 Certified for contact with Drinking Water. Certificates shall be included in submittal documents.

B. Shop Inspection:

The valve Manufacturer shall provide a six-week advance notice to the Engineer or Owner prior to performing tests and shall allow full access to Owner's representatives for inspection of manufacturing facilities, processes, and any specified testing. The Manufacturer shall perform all testing at the Manufacturer's cost, unless such testing is specifically indicated to be provided by the Owner. The valve Manufacturer shall accommodate for Owner representatives to observe valve factory testing. The valve Manufacturer shall provide a description and plan of the test setup and shall notify the Owner at least 30 days in advance of the time that each factory test will occur. The valve Manufacturer will be responsible for all above described costs for subsequent valve testing should the initial test fail.

C. Shop Testing:

Plunger Valves shall be shop tested prior to shipment in accordance with the following minimum standards:

1. Leakage Test: Plunger Valves shall be qualitatively tested to 1.1 times valve pressure rating to identify drip tight closure of valve seat, seal leaks and other problems in the assembly process in both flow directions.

2. Hydrostatic Test: Plunger Valves shall be hydrostatically tested to withstand 1.5 times of the valve's maximum design operating pressure rating to identify drip tight body enclosure.

3. A Functional Test: Plunger valves shall be tested for proper functionality. The test procedure shall consist of three (3) complete open/close cycles of operation with modulating valve actuator settings in increments of 5% and the functionality of other features of the valve (limit switches, torque switches, position switches, etc.).

4. The valve Manufacturer shall submit six copies of certified shop test reports that shall include all appropriate information including: hand wheel rotation direction, valve full stroke calibration data, pressure settings, operating times and visual inspection notes.

1.7 EXPERIENCE

A. The valve manufacturer shall have a minimum of ten (10) years of experience in the production and sales of plunger valves. The valve Manufacturer shall also have at least ten (10) installed Plunger Valve references in the Intermountain West. Valve manufacturer shall provide complete documentation to meet this requirement, including contact names and

telephone numbers that can verify field installations. Acceptance of the validity of submitted documentation is solely at the discretion of the client.

B. The valve manufacturer shall provide 24 hour manufacturers response for any field service requirement. Approved service agents, Licensee(s), or representatives of the manufacturer shall be permitted as long as the valve manufacturer is present. The valve manufacturer shall be responsible for its authorized agents and licensees. A detailed manufacturers signed service call write up, inclusive of photo-documentation, shall be provided without exception, by the valve manufacturer. The valve manufacturer shall be required to know and keep data files on all work performed, modifications and remediations as well as the agents performing the work. This data shall be permanently kept with the manufacturer regardless of licensee.

PART 2 - PRODUCTS

2.1 PLUNGER VALVE PERFORMANCE REQUIREMENTS

A. Performance: The Plunger Valve shall be designed to operate smoothly throughout the specified flow range without damaging cavitation, excessive noise, or excessive vibration. It shall not need vanes to prevent cavitation.

B. Noise: Operating noise levels shall not exceed 95 decibels (dBA) at a distance of three (3) feet from the valve at the normal flow point. Material stresses shall not exceed 1/5 of the ultimate or 1/3 of the yield strength of the material. Flow rate as a function of pressure drop across the valve shall be linear to within 3-8%.

C. The Plunger Valve must be capable of meeting the following liquid performance characteristics:

Operating Criteria				
Water Type	Screened Surface Water			
Particle Size (inch)	0.0625 – 0.25			
Hydraulic Grade Line Elevation (HGL)	Minimum Flow (gpm)	Net Upstream Working Pressure (psi)	Maximum Flow (gpm)	Net Upstream Working Pressure (psi)
Intake HGL = 5,882 ft	150	13	5,600	10
Maximum Surge Pressure (psi)	60			
Outlet Pressure (feet)	10 - 15			
Minor Loss Coefficient, K (Maximum)	10.8 (when valve is fully open)			

2.2 PLUNGER VALVE OPERATING REQUIREMENTS

A. Valve Assembly Components: Each Plunger Valve assembly shall consist of a flanged short conical inlet section having an internal cone to divert the water flow into the annular cross sectional area of the valve body.

B. An oval body section with an inner annular chamber shall be formed by the body shell. The plunger, with custom designed cylinder control trim, shall be an integral part of the internal slider-crank mechanism and shall be driven by a 90 degree AWWA worm gear. The control trim cylinder shall be field removable and replaceable with alternate control trim when hydraulic conditions change or new operating parameters are required.

C. The plunger shall move in an axial flow direction to increase or decrease the annular cross section open to the flow medium. The medium will flow around the plunger or when present, through the customized trim, from the outer annular chamber to the inner chamber to control and regulate pressure or flow.

D. The seals of the plunger valve shall allow the valve to be drip and bubble tight in both flow directions for the long term and without the need for premature seal replacement. The outside of the plunger shall seat against a double-oring sealing ring. The double -oring shall deflect and seal in both axial directions. The double oring will provide the best available design for both modulating and for open close service in the prevention of twist, roll and point loading of the plunger seal. The seal shall be insensitive to debris. The elastomeric profile sealing ring shall seat leak tight at the downstream end of the plunger. The elastomeric profile sealing ring shall be mechanically retained in the downstream flange of the valve body by a stainless steel seat ring. Valve shaft seals shall prevent the long term potential of water entering into the gear case. The valve operating shaft shall have five o-ring seals; two on the shaft at the crank mechanism and three on the shaft at the gear box. The o-ring seals shall maintain a drip tight seal regardless of modulation cycles or inactivity. The o-ring seals will prevent corrosion of the shaft body bore.

E. To prevent possible dislodging over the valve's life and or during prolonged modulation or transmitted pipeline vibration, the push rod linkages shall be mechanically retained with split pins. In addition, the control linkage and complete crank mechanism shall be either completely machined or investment casted. Exposed rough casting which could hide defects are not allowed.

F. Valves shall be provided with 4 integral feet per each 180 degree circumference. There shall be 4 total lifting lugs, one per each foot. The four lifting lugs shall be factory drilled and taped. They shall be sufficiently broad in placement to assist with rigging of an unbalanced load.

G. The valve shall function properly and without issue within any 180 degree flange rotation and the actuator with a left or right installation orientation.

2.3 PLUNGER VALVE DESIGN FEATURES

A. Plunger Valve must be a single piece body designed to avoid flow disturbance, corrosion between uncoated body sections and possible leakage. Valves bodies shall not be two or three piece and shall not have flange to flange body connections. The Plunger Valve shall feature a continuously increasing annular cross section and resulting linear increase of flow velocity to the full open position without producing damaging cavitation.

B. Plunger Valve design shall feature a customized designed plunger with tailored anti-cavitation trim with slots or orifice holes, to eliminate all cavitation damage. The area open

to flow on the plunger, slots or orifice holes, shall not be open to flow when the valve is placed in the closed position. The plunger shall be seated against the upstream quad-o ring and an elastomeric seat located in body downstream flange with the valve in the closed position. The elastomeric seat shall be properly kept in position in a groove in the body and the downstream stainless steel seat ring shall secure the elastomeric profile sealing ring from displacement. The profile seat ring shall not be penetrated by fasteners, exposed to the flow stream in the open position and shall not be subject to cold flow of the elastomer.

C. The Plunger Valve assembly shall axially recess in the upstream direction and flow water through the slots or orifice holes.

D. Plunger Valve design shall feature axial stroke movements, upstream and downstream, guided in the internal body by a rugged crank and push rod mechanism of stainless steel. The crank and push rod mechanism shall have an industry standard 90° angle of rotation stroke from open to close matching the travel for AWWA waterworks quarter turn valves. The provided actuator shall include a mechanical stop in the open and closed positions which will prevent attempts of actuator to hyper extend the plunger or place undesired stresses on the internal linkage system. The plunger shall slide and be contained in the axial position by guide rails. To prevent possible corrosion between the guide rails and the valve body, the guide rails shall be completely fused to the valve body in an overlay weld process to prevent any gaps or corrosion pathways. Guide rails which are riveted or bolted to the valve body are not acceptable for long-term operability and corrosion protection. The guide rails shall be bronze and shall be positioned around the plunger in an uneven quantity to reduce the potential for damaging harmonic vibration, clogging or excessive wear. The guide rails shall be low to no lead and very low zinc content to prevent dezincification (see Materials of Construction chart).

E. The movement of the plunger shall be controlled by means of an AWWA electric motor maintenance free irreversible, self-locking, quarter turn, 90 degree AWWA worm gear unit with externally adjustable mechanical stops to limit valve travel in both the open and closed positions. The valve stroke shall equal 90 degrees plus or minus 2 degrees, whereby the mechanical stops of the worm gear shall be engaged before the full extension or retraction of the plunger. In no instance shall the full output torque of actuator be allowed to be transmitted to the valve at its end of travel, either open or closed, without engaging the travel stops of the worm gear first. The AWWA worm gear unit shall be operated by a hand wheel or electric actuator. Only pneumatic or hydraulic cylinder actuators may utilize scotch yoke linkages to change linear piston force to rotational torque. As scotch yoke output torques are inconstant through their complete stroke, the submittals shall mathematically validate the actuator output torques exceed the required valve input torque, inclusive of AWWA safety factors, through the full stroke of the valve.

F. The design of the annular throat cross section open to flow shall ensure precise flow control over the open to close stroke of the plunger.

G. The proposed valve actuator shall operate in accordance with the requirements of Section 40 05 57 – Valve Actuators.

H. The Plunger Valve must be easy to maintain, as such it shall have the profile sealing ring in the downstream flange. The seal and ring shall be accessible via a dismantling joint installed

downstream of the valve. A mechanic shall not have to reach inside the valve to perform seat replacement. The profile sealing ring shall be interchangeable without dismantling the valve from the pipeline.

I. Connections: Valve end connections shall be provided by ANSI standard pattern flanges for the size and pressure rating specified.

J. The valve body shall come equipped with a threaded tapped plug suitable for draining the valve body cavity should maintenance or inspection be required and/or for installation of a pressure gauge.

2.4 MATERIAL REQUIREMENTS

A. Principal Component Parts Materials of Construction

Item	Size	Material	Specification
Valve Body	All	Ductile Iron	ASTM A536, GR. 60,40,18
Plunger	All	Stainless Steel	AISI 316
Regulating cylinder	All	Stainless Steel	AISI 316
Shaft Bushing		Bronze	ASTM C90800/ CuSn12
Crank shaft	All	Stainless Steel	AISI 420 –solid core, no chrome plating
Crank mechanism	All	Stainless Steel	AISI 316
Seat / Retaining ring	All	Stainless Steel	AISI 316
Plunger guide rails	All	Aluminum Bronze Welded Overlay	CuAl8 (lead <0.0020% Zinc < 0.008%
Quad-sealing-ring	All	EPDM hardness A:80, (=/- 5). Elongation >200%, Tensile >12 N/mm, Elasticity >25%	
Profile sealing ring	All	EPDM (only)	
Shaft O-Rings	All	EPDM	
Worm Gearbox		Housing: Ductile Iron GGG-40 Worm wheel: GGG-60 or bronze coupling: quenched and tempered steel acc. to 10083-2 Input drive shaft (secondary gear): stainless steel 10088-3	

B. All studs, bolts, washers, and nuts in contact with water shall be Type 304 stainless steel. Seat and seat ring retainers shall be Allen or hex head fasteners. Slotted screw fasteners shall not be used.

C. All materials of moving components in contact with each other shall be of dissimilar hardness to prevent galling. The valve shall be moved through an open-close-open cycle three (3) times after final assembly and prior to shipment to ensure this requirement.

D. Use fusion bonded epoxy coating - Submerged Metal, Potable Water. Type: Epoxy per Section 09 90 00 Protective Coatings as well as noted herein.

E. The valve manufacturer coating process shall include post preparation and coating application assurances of targeted performance. The manufacturer shall utilize and incorporate a QC process that includes Coating thickness Testing, Holiday Free Testing, Cross Linkage Testing, Impact Resistance Testing, Coating Adhesion Testing and Cathodic Disbonding Testing. The Quality Compliance testing shall remain on record with the manufacturer and available for review and approval.

F. The valve shall be blast coated to near white metal. The blast cleaned body shall be then thoroughly cleaned to remove all dust, grease, oil or other negative adhesion potentials. It shall meet the coating manufacturers recommended duration for humidity and temperature and at coating application. Coating shall take place within 12 hours of the blast cleaning process.

H. The applied coating shall be tested and signed and dated-verified holiday free with a dry film thickness of a minimum of 12 mils DFT or as specifically stated in the coatings section.

2.5 FLANGES

A. For design pressure up to and including 150 pounds per square inch (psi), use AWWA Class E steel flanges or use ANSI B16.5, Class 150 steel flanges.

B. For design pressures exceeding 275 psi, use ANSI B16.5, Class 300 steel flanges for pipe diameters up to and including 24 inches. Use ASME B16.47, Class 300 steel flanges for pipe diameters 26 through 36 inches.

C. Facing: Flanges of all classes shall be flat faced; without projection or raised face. Per manufacturer's design, a serrated concentric finish having with at least four (4) grooves (3 grooves/inch) finish shall be used to aid in gasket retention. The cutting tool employed shall have an approximate 0.06 in (1.52 mm) or larger radius. The resultant surface finish shell have a 250 to 500μin. (6.35 to 12.7 μm) roughness.

2.6 PLUNGER VALVE MANUFACTURER

Plunger Valve manufacturer:
Av-Tek VRX
Salt Lake City, UT

PART 3 - EXECUTION

3.1 INSTALLATION

A. Valve installation shall be in strict accordance with the Manufacturer's printed recommendations and the Contract Documents. Uncrated valve handling shall utilize all four lifting eyes.

B. Four (4) hard bound copies and one (1) CD of the Operations and Maintenance Manual shall be provided with the valve. The manuals shall include installation instructions, maintenance procedures and operation parameters.

3.2 WORKMANSHIP

A. Valves shall be free from manufacturing defects and shall be manufactured in a workman like manner.

B. Painting shall be per Section 09 90 00 – Protective Coatings. Grease and scale shall be completely cleaned from the valve prior to painting per Society for Protective Coatings (SSPC) standards.

C. Valves shall be manufactured under the direction of a registered professional engineer.

D. All carbon steel components shall be painted with a fusion bonded epoxy coating per Section 09 90 00 – Protective Coatings. A certificate of compliance with the purchaser's material specifications and the Manufacturer's quality assurance program shall be furnished with each valve.

3.3 FIELD TESTING AND PERFORMANCE

A. The valve manufacturer shall furnish all required start-up assistance and inspection of valve after installation at the Owner's facility. Representatives, Licensee(s) and authorized service agents of the valve manufacturer shall not perform any work inclusive of but not limited to, start up and testing, operating the valve without the valve manufacturer's on-site presence. The valve manufacturer shall be wholly responsible for any work performed by its Licensee or their authorized agents.

B. Valves shall be field leak tested by the Contractor to the specified operating pressure in the closed position and shall not leak. Field leakage relevant to the Plunger Valve shall be corrected by the valve Manufacturer at the valve Manufacturer's expense. Field leakage test results shall be certified by the Owner's Engineer or an appointee of the Owner, Manufacturer's onsite representative and Contractor.

C. Plunger Valves shall be subjected to onsite performance testing as part of the commissioning activities in accordance with a written performance test plan (including a continuous 7-day test). To the extent possible, the valve shall be subjected to variable flow conditions and exposure to the range of typical operating conditions. The flow, upstream and downstream pressures, noise levels, and vibration levels shall be documented and compared to the valve Manufacturer's shop test results.

D. The plunger valve, electric motor operator shall modulate to maintain either a fixed downstream pressure setpoint or flowrate setpoint. The command position signal shall be input into the facility PLC and maintained via a PI(D) loop from input data communicated from a downstream pressure transmitter or magnetic flow meter. Start-up will consist of setting each of these loops independently including an appropriate time response for valve movement and inclusive of a deadband, appropriately set for the downstream demand conditions of the system. The complete system shall act as an integrated unit with a continuous feedback loop. The start-up procedures shall include setting this loop control system.

E. Upon completion of the necessary field testing, the shop test results and field test results comparison shall be discussed expressly with the valve manufacturer. Representatives, Licensee or other stake holders may accompany any discussions but shall not be an acceptable substitute for the valve manufacturer's presence.

3.4 WARRANTY

A. The plunger valve Manufacturer shall warrant its products, including actuators incorporated in the work, to be free from defects in materials, workmanship and performance for a period of five years from the date of receipt. Upon notice by the Owner, any damage or defect found during the warranty period shall be promptly repaired or replaced by the valve Manufacturer at no cost to the Owner. Where a valve is for sale via a Licensee of the valve manufacturer/ the Licensor, and as this agreement is subject to dissolution and or termination to the potential detriment of the Owner, both the Licensee and the valve Manufacturer, Licensor, shall be wholly responsible for the warranty. The warranty claim and resolution shall be severable and actionable to both Licensee and Licensor. Warranty claims and resolution will not need to be exhausted through the Licensee and shall remain in effect for the total duration of the warranty period to the Licensor. Performed actions of authorized agents of the Licensee shall constitute actions of the valve manufacturer and shall be the responsibility of the valve Manufacturer/Licensor. This warranty shall be in effect regardless of the contract between the contracted entity/Licensee and the Licensor.

END OF SECTION

SECTION 40 05 57
WEIR GATES

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide weir gates, complete and operable, in accordance with the Contract Documents. See drawings for weir gate locations.

B. Gates and operators shall be supplied with all the necessary parts and accessories indicated on the drawings, specified or otherwise required for a complete, properly operating installation and shall be the latest standard product of a manufacturer regularly engaged in the production of water control gates.

C. The requirements of Section 40 05 52 – Valve and Gate Actuators apply to this Section.

1.2 REFERENCE STANDARDS

A. Except as modified or supplemented herein, all gates and operators shall conform to the applicable requirements of AWWA C562, latest edition.

ANSI/AWWA C562	Open-Channel, Fabricated-Metal Slide Gates and Open-Channel, Fabricated-Metal Weir Gates
ASTM A276	Stainless Steel Bars and Shapes
ASTM B209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B308	Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM B584	Copper Alloy Sand Castings for General Applications
ASTM D2000	Standard Classification System for Rubber Products in Automotive Applications
ASTM D4020	Ultra-Molecular-Weight Polyethylene Molding and Extrusion Materials

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures.

B. Furnish submittals for gate actuation in accordance with Section 40 05 52 – Valve and Gate Actuators.

C. Provide factory test certificates.

1.4 QUALITY ASSURANCE

A. The leakage allowance for weir gates under the design seating and unseating head shall not exceed 0.1 gpm/ft of seating perimeter or the leakage rate of AWWA C 562, whichever is the most stringent.

B. The manufacturer shall have experience in the production of substantially similar equipment, and shall show evidence of satisfactory operation in at least 50 installations. The manufacturer's shop welds, welding procedures and welders shall be qualified and certified in accordance with the requirement of the latest edition of ASME, Section IX.

C. Factory Testing: Gates shall be factory-assembled and functional-tested prior to delivery to the Site. Test certificates shall be submitted.
   1. Weir gates shall be substantially watertight under the design head conditions. Leakage shall not exceed 0.1 U.S. gallon per minute per foot (1.25 l/min per meter) of seal periphery under the design seating head and 0.1 U.S. gallon per minute per foot (1.25 l/min per meter) of seal periphery for the design unseating head.
   2. Weir gates shall be designed to withstand the design head (maximum design head shall be taken as the height of the slide unless otherwise shown in the schedule).

PART 2 - PRODUCTS

2.1 GENERAL

A. All gates shall comply with AWWA C562 unless indicated otherwise. Weir gates shall be self-contained and of the rising stem configuration.

B. Gates shall be new and of current manufacture, adequately braced to prevent warpage and bending under the intended use.

C. Gate actuators shall be sized, selected, and furnished by the gate manufacturer. Gate actuators throughout the project shall be products of a single manufacturer. Power lifting devices shall be in accordance with Section 40 05 52 – Valve and Gate Actuators.

2.2 WEIR GATES

A. Stem and Couplings: The operating stem shall be of stainless steel designed to transmit in compression at least two (2) times the rated output of the operating manual mechanism with a 40 lb. (178 N) effort on the crank or handwheel.
   1. The stem shall have a slenderness ratio (L/r) less than 200. The threaded portion of the stem shall have machine cut threads of the Acme type.
   2. Where a hydraulic, pneumatic or electric operator is used, the stem design force shall not be less than 1.25 times the output thrust of the hydraulic or pneumatic cylinder, with a pressure equal to the maximum working pressure of the supply or 1.25 times the output thrust of the electric motor in the stalled condition.
   3. For stems in more than one piece and with a diameter of 1 ¾ inches (45 mm) and larger, the different sections shall be joined together by solid bronze couplings. Stems with a diameter smaller than 1 ¾ inches, shall be pinned to an extension tube.

4. The couplings shall be grooved and keyed and shall be of greater strength than the stem.

B. Stem Guides: Stem guides shall be fabricated from aluminum. The guide shall be equipped with an UHMWPE bushing. Guides shall be adjustable and shall be spaced in accordance with the manufacturer's recommendation. The L/r ratio shall not be greater than 200.

C. Stem Cover: Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents as well as a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

D. Unless otherwise indicated, materials of construction shall be in accordance with AWWA C562, suitable for the service. Materials used in the fabrication of the slide gates shall conform to the requirements of the standards designated for each material indicated below:

E.

Description	Material Standards
Frame, Yoke, Slide, Stem extension	Aluminum 6061-T-6 ASTM B-209, ASTM B-211
Side and Bottom seals	"J" bulb Type, Neoprene, ASTM D 2000. Self-adjusting or Flat seals alone are not acceptable
Bearing bars, Guides, Stem guide liner	Ultra High Molecular Weight Polyethylene ASTM D4020
Threaded stem, Stem guides, Hand crank	Stainless steel ASTM A-276, Type 304 or 304L
Fasteners	Stainless steel Type 304 or 304L
Pedestal / Wall Bracket	Cast Iron ASTM A126, class B or Mild Steel A36/A36M
Stem cover	Polycarbonate ASTM A-707
Lift and stop nut	Manganeze bronze , ASTM B584, UNS-C86500

F. Weir gates shall be downward opening.
1. Downward opening weir gates mounted in an unseating position shall have seals along the side and bottom of the slide.

G. Guide Frames: The gate frame shall be constructed of extruded members welded to form a rigid one-piece frame. The frame shall be of the flange back design, suitable for mounting on a concrete wall (CW). The guide slot shall be made of UHMWPE (ultra high molecular weight polyethylene). Weir gate guide frames shall be the wall mounted type (with or without flange (spigot), or embedded type; and self-contained.
1. The guide frames shall be of the proper size to allow lifting and lowering of the gate smoothly.
2. The clear opening shall be the same size as the waterway, unless otherwise indicated.
3. Guide frames shall be extended, 3 feet 6 inches above the walkway to match the height of the handrail, unless otherwise shown. Where a gate is mounted in an opening between 2 sections of handrail, additional horizontal members shall be added to the gate frame to match the handrail, guardrail, and kickplate spacing of the adjacent railing. Horizontal members shall be arranged so that the railing will not interfere with operation of the actuator.

H. Guides and Seals: The guides shall be made of UHMWPE (ultra high molecular weight polyethylene) and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.
   1. The bottom and side seals shall be made of neoprene rubber seals. The sealing system shall maintain efficient sealing in any position of the slide and let the water flow only in the open part of the gate.
   2. Seals shall maintain the specified leakage rate in both seating and unseating conditions.

I. Lifting Devices: Manual, hydraulic cylinder or electric actuated operators shall be provided by the gate manufacturer. All bearings and gears shall be totally enclosed in a weather tight housing. The pinion shaft of crank-operated mechanisms shall be constructed of stainless steel and supported by roller or needle bearings.
   1. Each manual operator shall be designed to operate the gate under the maximum specified seating and unseating heads by using a maximum effort of 40 lbs (178 N) on the crank or handwheel, and shall be able to withstand, without damage, an effort of 80 lbs (356 N).
   2. The crank shall be removable and fitted with a corrosion resistant rotating handle. The maximum crank radius shall be 15 inches (381 mm) and the maximum handwheel diameter shall be 24 inches (610 mm).
   3. The centerline of the manual actuator shall be approximately 3-feet above the base for pedestal mounted, and approximately 4-feet above the floor for frame-mounted actuator.
   4. Provide actuator pedestal where shown in drawings. Provide mounting bracket for actuator pedestal. Size the bracket and mounting hardware per manufacturer recommendations.

J. Yoke: Self-contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection shall be 1/360 of the gate's span.

K. Manufacturers, or Equal
   1. Golden Harvest, Inc.
   2. Rodney Hunt Company
   3. Fontaine
   4. Hydro Gate Corp.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Weir gates shall be installed in strict accordance with the drawings and manufacturer shop drawings.

B. Field modifications of or to gates or gate frames will not be permitted without prior written acceptance from the manufacturer.

END OF SECTION

SECTION 40 05 63
BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide ball valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 - Valves, General apply to this Section.

C. The requirements of Section 40 05 52 - Valve and Gate Actuators apply to this Section.

D. The requirements of Section 46 33 00 - Chemical Feeding Equipment, General apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures and 40 05 51 - Valves, General.

PART 2 - PRODUCTS

2.1 METAL BALL VALVES (3-INCHES AND SMALLER)

A. General: Unless otherwise indicated, general purpose metal ball valves in sizes up to 4-inches shall have actuators in accordance with Section 40 05 52 - Valve and Gate Actuators.

B. Body: Ball valves up to and including 1.5-inches in size shall have bronze or carbon steel 2 or 3 piece bodies with screwed ends for a pressure rating of not less than 600 psi WOG. Valves 2-inches to 3-inches in size shall have bronze or carbon steel 2 or 3 piece bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi unless otherwise indicated.

C. Balls: The balls shall be solid chrome-plated brass or bronze, or stainless steel, with standard port (single reduction) or full port openings.

D. Stems: The valve stems shall be of the blow-out proof design, of bronze, stainless steel, or other acceptable construction, with reinforced teflon seal.

E. Seats: The valve seats shall be of teflon or Buna-N, for bi-directional service and easy replacement.

F. Manufacturers, or Equal
   1. Conbraco Industries, Inc. (Apollo)
   2. ITT Engineered Valves
   3. Neles-Jamesbury, Inc.
   4. Watts Regulator

5. Worcester Controls

2.2 PLASTIC BALL VALVES (1.5-INCHES AND SMALLER)

A. General: Plastic ball valves for corrosive fluids shall be made of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), or polyvinylidene fluoride (PVDF), as recommended by the manufacturer for the specific fluid application. Valves shall have manual actuators in accordance with Section 40 05 52 - Valve and Gate Actuators, unless otherwise indicated.

B. Construction: Plastic ball valves shall have true-union ends or flanged ends to mate with ANSI B 16.5, class 150 flanges for easy removal. The balls shall have full size ports and teflon seats. Body seals, union O-ring seals, and stem seals shall be in accordance with the corrosion resistance requirements of [Section 46 33 00]. External (without entering into the wetted area) seat packing adjustment is preferred. Metal reinforced stems to prevent accidental breakage are preferred. Ball valves for sodium hypochlorite solution service shall be drilled through the ball or body per valve manufacturer recommendation to relieve offgas and equalize pressure across the valve. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F for PVC and CPVC, with decreasing ratings for higher temperatures and other plastics.

C. Manufacturers, or Equal
1. ASAHI-America
2. George Fischer, Inc.
3. NIBCO Inc., (Chemtrol)
4. Plast-O-Matic Valves, Inc.
5. Spears Mfg. Co.
6. Watts Regulator

PART 3 - EXECUTION

3.1 GENERAL

A. Valves shall be installed in accordance with Section 40 05 51 – Valves, General. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

END OF SECTION

SECTION 40 05 64
BUTTERFLY VALVES

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide butterfly valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 11 00 00 – Equipment General Provisions apply to this Section.

C. The requirements of Section 40 05 51 - Valves, General apply to this Section.

D. The requirements of Section 40 05 52 - Valve and Gate Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 – Valves, General.

B. Shop Drawings
   1. Complete Shop Drawings of butterfly valves and actuators.
   2. Drawings showing valve port diameter complete with dimensions, part numbers, and materials of construction.
   3. Certification of proof-of-design test from the valve manufacturer.
   4. Certification: The Contractor shall obtain written certification from the butterfly valve manufacturer, addressed to the Owner, stating that the butterfly valves and the valve operators will efficiently and thoroughly perform the required functions in accordance with these Specifications and as shown, and that the manufacturer accepts joint responsibility with the Contractor for coordination of all butterfly valves and valve operators, including motors, drives, controls, and services required for proper installation and operation of the completely assembled and installed units. The Contractor shall submit all such certificates to the construction manager.
   5. Technical Manuals: The Contractor shall furnish technical manuals for the butterfly valves, manual operators, and electric motor valve operators under one cover and in accordance with the requirements of Section 01 33 20 – Submittal Procedures.
   6. Valve Labeling: The Contractor shall submit a schedule of butterfly valves to be labeled indicating in each case the valve location and the proposed wording for the label.
   7. Field Procedures: Written instructions for field procedures for erection, adjustments, inspection, and testing shall be provided prior to delivery of the butterfly valves and valve operators.

1.3 QUALITY ASSURANCE

A. Valves shall be subjected to performance, leakage, and hydrostatic tests in accordance with procedures and acceptance criteria established by AWWA C504.

PART 2 - PRODUCTS

2.1 RUBBER SEATED BUTTERFLY VALVES (AWWA)

A. General: Butterfly valves for water working pressures up to 250 psi shall conform to ANSI/AWWA C504 - Rubber Seated Butterfly Valves, subject to the following requirements. Valves shall be of the size and class indicated. Flanged valves shall have Class 150 or Class 250 flanges conforming to ANSI B16-1.

B. Manual Actuators: Actuators shall conform to Section 40 05 52 - Valve and Gate Actuators and to ANSI/AWWA C540 - Power Actuating Devices for Valves and Sluice Gates, subject to the following requirements. Unless otherwise indicated, all manually-actuated butterfly valves shall be equipped with a handwheel and 2-inch square actuating nut and position indicator. Screw-type (traveling nut) actuators will not be permitted for valves 30 inches in diameter and larger.

C. Worm Gear Actuators: Valves, 30 inches and larger, as well as all submerged and buried valves, shall be equipped with worm-gear actuators, lubricated and sealed to prevent entry of dirt or water into the housing.

D. Manufacturers, or Equal
   1. De Zurik Corporation.
   2. Kennedy Valve.
   3. Mueller

2.2 HIGH PERFORMANCE BUTTERFLY VALVES

A. General: High-performance butterfly valves shall be of the ANSI class 300, lugged design, suitable for working pressures up to 740 psi at temperatures ranging from -20 degrees F to 100 degrees F.

B. Body: The valve body shall be of carbon steel to mate with ANSI class 300 flanges; conforming to ASTM A 216 - Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, Type WCB, or ASTM A 515 - Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate-and Higher-Temperature Service, Grade 70.

C. Disc: The disc shall be offset, of Type 316 or 317L Stainless Steel, conforming to ASTM A 351 - Specification for Steel Castings, Austenitic, for High-Temperature Service, or ASTM A 743 - Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, and Nickel-Base Corrosion - Resistant for General Application, respectively.

D. Seat: The valve shall have a soft seat, retained in the body by an Inconel or Type 316 stainless steel ring. The seat material shall be PTFE, TFE, or filled TFE.

E. Shaft: The shaft shall be one-piece construction, Type 316 or 17-4 PH stainless steel.

F. Bearings: The shaft bearings shall be corrosion-resistant and self-lubricating, made of Type 316 stainless steel backed with TFE, or Type 317 stainless steel.

G. Packing: The shaft packing shall be adjustable and field-replaceable of TFE chevron type design or PTFE V-flex style.

H. Actuator: Gear assisted actuators shall be provided for all high performance butterfly valves. The valve actuators for high performance butterfly valves shall be of the traveling nut type or worm-gear type designed for buried service. Actuators shall be designed for the full rating of the valve, and an input torque of 300 foot pounds against the fully adjustable open and closed position stops, as required by AWWA C504. Manual actuators shall allow for positive throttling and locking in any position from open to close.

I. Testing: The valves shall be factory-tested in accordance with Section 40 05 51 - Valves, General.

J. Manufacturers, or Equal
   1. De Zurik Corporation
   2. Henry Pratt Company

2.3 BUTTERFLY VALVES FOR AIR SERVICE

A. General: Butterfly valves for air systems shall be specifically designed for this service and meet or exceed the design, strength, performance, and testing standards of AWWA C504. Valves shall be suitable for pressures from vacuum to 125 psi and temperatures from minus 40 degrees F to 250 degrees F.

B. Body: The valve body shall be of cast iron conforming to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, Class B, with either wafer, lug, or flanged design as indicated, drilled to ANSI B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, Class 125.

C. Disc: The disc shall be of ductile iron conforming to ASTM A 536 - Ductile Iron Castings, or cast iron conforming to ASTM A 48 - Gray Iron Castings, or ASTM A 126 with an edge of monel, Type 316 stainless steel, or nickel. The disc shall be designed with the air-profile or other suitable shape. Sprayed or plated disc edges are not acceptable.

D. Seat: The elastomer seat shall be in the body. It shall be field-replaceable without special tools. Except for use with petroleum-base fluids, the seat material shall be Ethylene-Propylene-Diene Monomer (EPDM), or other suitable material, to provide a tight shut-off at the temperatures above.

E. Shaft: The valve shaft shall be of Type 316 or 304 stainless steel with sufficient strength to allow for the increased torque for air service.

F. Bearings: Shaft bearings shall be of the self-lubricating corrosion-resistant sleeve type.

G. Packing: The packing shall be of the adjustable or self-adjustable (O-ring) type, suitable for the temperature and service conditions.

H. Manual Actuators: Unless otherwise indicated, manually-actuated butterfly valves shall be equipped with a handwheel and 2-inch square actuating nut and position indicator. Screw-type (traveling nut) actuators will not be permitted for valves 30-inches and larger.

I. Worm Gear Actuators: Valves 30-inches and larger shall be equipped with worm-gear actuators, lubricated and sealed to prevent entry of dirt or water into the housing.

J. Electric Actuators: Electric actuators shall meet the requirements of AWWA C540 and be in accordance with Section 40 05 52 – Valve and Gate Actuators. Electric actuators in open/close service shall be rated to produce output torque of at least 1.5 times the required valve maximum seating or maximum dynamic torque whichever is greater. For valves in modulating service with dynamic torque exceeding the seating torque, the rated output torque of the actuator shall be twice the dynamic torque required by the valve. Actuator rated torque is defined as pullout torque rated at 10 percent below the rated voltage of the motor. The torque switch shall be field set at no greater than 60 percent and 50 percent of the maximum actuator rated torque for open/close service and modulating service, respectively. After plant startup, the manufacturer shall prepare a certification including a torque curve to demonstrate that the torque requirements have been met.

K. Testing: Valves shall be factory leak tested in accordance with AWWA C504.

L. Manufacturers, No "Or-Equals":
1. DeZURIK Water Controls Corporation
2. Henry Pratt Company
3. Rodney Hunt Company

2.4 PVC BUTTERFLY VALVES (6-INCH DIAMETER AND SMALLER)

A. General: Valves shall be suitable for steady-state water working pressures and steady-state differential pressures up to 150 psi and for water having a pH range from 6 to 10 and temperature range from 33 to 90 degrees F. The Contractor shall be responsible to insure that the selected butterfly valve will fully open and close without any physical interference at all with schedule 80 PVC Van Stone flanges.

B. Body: Butterfly valves shall be all solid thermoplastic Polyvinyl Chloride (PVC) butterfly valves of the lined body design and shall be suitable for bubble tight shut-off service as well as throttling service. The liner and disc shall be the only wetted parts. All non-plastic exterior valve components, including stem and miscellaneous hardware, shall be Type 316 stainless steel.

C. Disc: The disc shall be made of Ethylene-Propylene-Dene Monomer (EPDM) or Polypropylene (PP) material. The chord length of the valve disc shall be less than the internal diameter of the pipe or flange to which it is to be installed.

D. Seat: Seat shall be of EPDM material to provide bubble-tight seating. The seat shall totally encapsulate the body with no need for flange gaskets for installation. The seat shall be field-replaceable without special tools.

E. Stem: Stems shall be made of Type 316 stainless steel. If connecting pins or screws are required for a particular manufacturer's design, then the disc as well as the connecting hardware shall be Type 316 stainless steel.

F. Stem Bushing: The stem busing shall be a non-corrosive, heavy-duty acetal bushing.

G. Stem Seal: The stem seal shall be a double "U" cup seal or O-ring design which is self-adjusting and provides positive sealing in both directions and is suitable for the service conditions.

H. Flange Style: All PVC butterfly valves 8-inch and smaller on suction side of pumps shall be lug-style valves. All other PVC butterfly valves shall be wafer type, unless otherwise specified.

I. Actuators: Actuators shall conform to Section 40 05 52 – Valve and Gate Actuators and to ANSI/AWWA C540 – Power Actuating Devices for Valves and Sluice Gates. Unless otherwise specified, all PVC butterfly valves 6-inch and smaller shall have manual lever operators. Manual lever type actuators shall allow for positive throttling and have at minimum 10 stop positions from open to closed position for positive locking of the valve.

J. Manufacturers, or Equal;
   1. Asahi America
   2. Hayward

2.5 DOUBLE ECCENTRIC BUTTERFLY VALVES (AWWA)

A. General: The butterfly valve shall be of a double offset design whereby the centerline of the disc is horizontally and vertically offset from the body seat and where the elastomeric seat release compression only after a few degrees of the opening. Butterfly valves shall be rated for working pressures of no less than 350 PSI and shall provide zero leakage at full rated pressure.

B. Body: Valve shall conform to lay length standard dimensions set forth in AWWA C504 Short Body and shall be supplied with integral ANSI B16.1 Class 250 flanges. The valve size, pressure rating, year of manufacture and manufacturer's name and model shall be cast onto the valve body or be on a permanently attached nameplate.

C. Shaft Seals: The shaft seals shall ensure the upper and lower valve shafts remain non-wetted and prevent pressurized system water from entering the uncoated valve disc hub and valve body shaft bore. The outer shaft seals shall consist of five O-rings in a removable bronze cartridge bolted to the valve body and not retained by the valve actuator. Neither pull down packing glands nor braided compression V-type packing are allowed. Back shaft shall be positively fixed to the disc, eliminating the risk of blow out of shaft.

D. Body: Valve bodies shall be ductile iron, ASTM A536 65-45-12 or A536 60-40-18, with ANSI B16.1s. Pre-drilled lifting holes lugs shall integrally be provided in each flange to assist in the installation and removal of valve from the pipeline.

E. Disc: The disc shall be ductile iron, ASTM A536-65-45-12 or ASTM A536 60-40-18. The disc shall be secured to the valve shaft using mechanically retained stainless steel shaft locking bolts. Tangential pins that penetrate the front of the disc shall not be allowed.

F. Shaft: Both upper and lower valve shafts shall be of high strength ASTM 2205 Duplex grade Stainless Steel.

G. Elastomeric Seal: Valve seats shall be EPDM mounted on the valve disc with AISI 316 Stainless Steel seat retainer. The seat retainer shall be counter bored and drilled. Seat retaining

fasteners shall be AISI 316 Stainless Steel and shall not extrude above the seat retaining ring. Seat shall be field replaceable and adjustable with common tools.

H. Metallic Seat: The metallic body seat shall be high nickel alloy and applied to the valve body by means of a machined weld overlay process eliminating the possibility of leakage through the body/seat joint.

I. Shaft Bearings: Valve shaft bearings shall be corrosion resistant, self-lubricating sleeve type made of bronze. Non-metallic shaft bearings are not allowed.

J. Coating: The iron surfaces of the valve body and disc shall be coated with minimum 10 mil DFT fusion bonded epoxy.

K. Testing: Each valve shall be supplied with a factory inspection certificate outlining body pressure test, leakage test, valve size, valve serial number, pressure rating, body heat No., disc heat No., stem heat No., seat material and seat heat No.

L. Manual Actuators: Actuators shall conform to ANSI/AWWA C540, subject to the following requirements. All actuators shall be self-locking worm gear type and shall hold the valve disc in the closed, open and any intermediate position without creeping or fluttering and be supplied from known and reputable gear manufacturer.

M. Manufacturers, or Equal
1. Av-Tek Valve USA

PART 3 - EXECUTION

3.1 INSTALLATION

A. Exposed butterfly valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator. Installation shall be in accordance with Section 40 05 51 – Valves, General.

END OF SECTION

SECTION 40 05 65
VALVES FOR PUMP CONTROL AND CHECK SERVICE

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide check valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 - Valves, General apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 – Valves, General.

PART 2 - PRODUCTS

2.1 SWING CHECK VALVES (3-INCHES AND LARGER)

A. General: Swing check valves for water and general service shall be of the outside lever and spring or weight type, in accordance with AWWA C 508 - Swing-Check Valves for Waterworks Service, 2-in. through 24-in. NPS, unless otherwise indicated, with full-opening passages, designed for a water-working pressure of 150 psi. Units shall have a flanged cover piece to provide access to the disc. Where indicated, swing check valves shall be provided with position indicators.

B. Body: The valve body and cover shall be of cast iron conforming to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with flanged ends conforming to ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, or be mechanical joint ends, as indicated.

C. Disc: The valve disc shall be of cast iron, ductile iron, or bronze conforming to ASTM B 584 - Copper Alloy Sand Castings for General Applications.

D. Seat and Rings: The valve seat and rings shall be of bronze conforming to ASTM B 584 or B 148 - Aluminum-Bronze Castings or of Buna-N.

E. Hinge Pin: The hinge pin shall be of bronze or stainless steel.

F. Dashpot: A bottom-mounted or side-mounted hydraulic dashpot shall be provided to prevent reverse flow and to alleviate water hammer during the closing cycle of the valve. The dashpot shall have 2 or 3 stage closing rates, depending on manufacturer's recommendation for intended service: For the 2 stage closing rate, the first stage shall be adjustable from 100 to 10 percent. The second stage shall be adjustable from 10 to zero percent. For the 3 stage closing rate, the first stage shall be adjustable from 100 to 50 percent. The second stage shall be adjustable from 50 to 10 percent. The third stage shall be adjustable from 10 to zero percent. Each rate shall be infinitely and independently field adjustable depending on the

system requirement. The dashpot shall be a self-contained oil system separate and independent from the pipeline fluid. The oil reservoir for the closing cycle shall be stainless steel, open to the atmosphere with an air breather cap to allow oil level changes in the reservoir and also to prevent contamination of the oil from any outside source. The oil reservoir for the opening cycle shall be stainless steel, be hermetically sealed to contain pressure (air over oil), and shall be equipped with a 3-inch diameter pressure gauge and pneumatic fill valve. There shall be a provision for disconnecting the each dashpot from the valve for servicing, without removal of the valve.

G. Manufacturers, or Equal
   1. APCO (Valve and Primer Corp.)
   2. Kennedy Valve
   3. Mueller Company
   4. Stockham Valves and Fittings
   5. Golden Anderson
   6. VAL-MATIC (Valve and Manufacturing Corporation)

2.2 SWING CHECK VALVES (2-1/2 INCHES AND SMALLER)

A. General: Swing check valves for steam, water, oil, or gas in sizes 2-1/2 inches and smaller shall be suitable for a steam pressure of 150 psi and a cold water pressure of 300 psi. Units shall have screwed ends unless otherwise indicated, and screwed caps.

B. Body: The valve body and cap shall be of bronze conforming to ASTM B 763 - Copper Alloy Sand Castings for Valve Application, or ASTM B 584 with threaded ends conforming to ASME B1.20.1 - Pipe Threads, General Purpose (inch).

C. Disc: Valves for steam service shall have bronze or brass discs conforming to ASTM B 16 - Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines, and for cold water, oil, and gas service replaceable composition discs.

D. Hinge Pin: The hinge pins shall be of bronze or stainless steel.

E. Manufacturers, or Equal
   1. Crane Company
   2. Milwaukee Valve Company
   3. Stockham Valves and Fittings
   4. Wm. Powell Company

2.3 INTERNAL SPRING-LOADED CHECK VALVES (GLOBE STYLE – SILENT CHECKS)

A. General: Internal spring-loaded check valves for water pumps, compressors, gas, air, and steam shall be of the full-flow internal spring-loaded poppet type. The valves shall be designed for a water-working pressure of not less than 150 psi unless otherwise indicated.

B. Body: The bodies of valves 3-inches and larger shall be of cast iron conforming to ASTM A 126 with 125 lb flanged ends conforming to ASME B 16.1 unless otherwise indicated. Where necessary, there shall be a positive, watertight seal between the removable seat and the valve body. The stem guide shall be integrally cast with the body or screwed into the body.

C. Valves smaller than 3-inches shall have bronze bodies with screwed ends conforming to ASME B 1.201, suitable for a minimum working pressure of 200 psi, and a temperature of 250 degrees F, unless otherwise indicated. The type of bronze shall be suitable for the intended service.

D. Disc and Stem: The disc and stem of all valves in sizes 3-inches and larger shall be of bronze conforming to ASTM B 584 - Copper Alloy Sand Castings for General Applications, or stainless steel. The stem shall have 2 point bearings. The downstream bearing shall have a bronze or other suitable bushing, to provide a smooth operation.

E. Valves smaller than 3-inches shall have discs and retaining rings of Teflon, nylon, or other suitable material, and stems of bronze, brass, or stainless steel, suitable for the intended service.

F. Stem Guide: The stem guide shall be either firmly fixed in the valve body to prevent it from sliding into the adjacent pipe and damaging the pipe lining, or the valve manufacturer shall provide each valve with one matching flange compatible with the adjacent pipe and its lining to prevent damage to the lining. The compatible flange shall be part of the Shop Drawing submittal.

G. Seat**:** Valves for general service at temperatures up to 250 degrees F shall have bubble-tight shut-off with resilient seats of Buna-N, Teflon, or other suitable material. Valves for steam service and temperatures over 250 degrees F shall have metal-to-metal seating of bronze or stainless steel, as recommended by the manufacturer for the specific service condition. Resilient seats shall be firmly attached to the seating ring by compression molding or other acceptable method.

H. Spring: Valves in sizes 3-inches and larger shall have Type 316 stainless steel springs, and valves smaller than 3-inches shall have stainless steel or beryllium copper springs, as suitable for the service. The spring tension of the valves shall be designed for the individual pressure condition of each valve.

I. Manufacturers, or Equal
   1. APCO (Valve and Primer Corp.)
   2. CPV (Combination Pump Valve Company)
   3. Miller Valve Co., Inc.
   4. VAL-MATIC (Valve and Manufacturing Corporation)

2.4 TILTED DISC CHECK VALVES (3 – 48 INCH)

A. General: This specification covers the design, manufacture, and testing of Tilted Disc Check Valves suitable for pressures up to 400 psig (2750 kPa) (3"-12") and 350 psig (2,070 kPa) (14"+) water service. The Check valves shall be of the Tilted Disc metal seated, full body type capable of accepting optional bottom or top mounted oil dashpots.

B. Standards: The valves shall be certified to NSF/ANSI 61 Drinking Water System Components - Health Effects and certified to be Lead-Free in accordance with NSF/ANSI 372. A 20 in. (500mm) valve or larger shall be proof of design cycle tested through 250,000 cycles in the horizontal position and leak tested at the rated pressure. The leakage rate shall be less than 1 fluid ounce per hour per inch of valve size after the test.

C. Connection: The valves shall be provided with drilled flanges in accordance with ANSI B16.42 Class 300 iron flanges. Ductile iron flanges shall be flat faced. Flanged inspection ports shall be provided upstream and downstream of the valve disc for inspection or use with optional dashpots on 6 in. and larger valves.

D. Design: The valve body shall consist of two sections bolted together as a central diagonal flange inclined at an angle of 55 degrees. The inlet body section shall contain a seat ring positioned and captured by the diagonal flange. The outlet body section shall accept eccentrically located pivot pin trunnions with sealed covers and lubrication grease fittings. The eccentric pivot trunnions shall be located to divide the disc into approximately 1/3 and 2/3 proportions and also allow the seating surface of the disc to rotate away from the seating surface of the seat ring without contact. Clearance shall be provided between the pivot pin and bushing when the disc is seated to prevent binding and to ensure a tight seal. The minimum pivot pin diameter shall be as shown below.

Valve Size (in)	3	4	6	8	10	12	14	16
Pin Diameter (in)	9/16	5/8	1-1/8	1-3/8	1-5/8	1-7/8	2-1/8	2-3/8

E. Materials: The valve body shall be constructed of ASTM A126 Class B cast iron for Class 250 valves up to 10 in. (250mm). 12 in. (300mm) and larger Class 250 valves shall be constructed of ductile iron ASTM A536 Grade 65-45-12. The disc in sizes up to 10 in. (250mm) shall be one-piece construction with integral seat and constructed of ASTM B148 Alloy C95400 aluminum bronze. 12 in. (300mm) and larger discs shall be ASTM A536 Grade 65-45-12 ductile iron. The disc seating ring shall be ASTM B271 Alloy C95500 centrifugally cast aluminum bronze. The mating seat ring located in the body shall be ASTM B271 Alloy C95400 centrifugally cast aluminum bronze. The pivot pins shall be ASTM B505 Alloy C95500 aluminum bronze and shall be guided by a bushing constructed of ASTM B505 Alloy C95400 aluminum bronze (12 in./300mm and larger valves).

F. Testing: The valves shall be hydrostatically tested at 1.5 times their rated cold working pressure. Additional tests shall be conducted per AWWA, ANSI, MSS or API standards when specified. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.

G. Coatings: The exterior of the valve shall be coated with a universal alkyd primer. The valve interior shall be coated with an epoxy coating approved for potable water.

H. Manufacturers, or Equal
1. Val-Matic Valve & Mfg. Corporation

2.5 PLASTIC BALL CHECK VALVES

A. General: Plastic ball check valves for corrosive fluids, in sizes up to 4-inches, shall be used for vertical up-flow conditions only, unless the valves are provided with spring actions.

B. Construction: The valve bodies and balls shall be of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polyvinylidene fluoride (PVDF), or polypropylene (PP) construction, as best suited for each individual service condition. They shall have unions with socket connections or flanged ends conforming to ASME B16.5 - Pipe Flanges and Flanged Fittings, class 150. Seals shall have Viton O-rings, and valve design shall minimize possibility of the balls sticking or chattering. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F.

C. Manufacturers, or Equal
   1. ASAHI-AMERICA
   2. George Fischer, Inc.
   3. NIBCO Inc. (Chemtrol Division)
   4. Spears Mfg. Co. (PVC, CPVC, AND PP only)

2.6 METAL BALL AND LIFT CHECK VALVES

A. General: Metal ball check valves for saturated steam, oil, water, and gas in sizes 1/2- up to 1-inch shall be used for horizontal installation only. Lift check valves for LP gas in sizes 1/4 up to 2-inches shall be used for horizontal installation only.

B. Construction: The ball check valve body and cap shall be bronze ASTM B 584. Ball disc shall be stainless steel construction, as best suited for each individual service condition. The union cap shall provide a tight joint and be easily dismantled when necessary. They shall have screwed connections. The valves shall be suitable for a maximum working non-shock pressure of 150 psi saturated steam or non-shock cold water, oil, and gas rating of 300 psi.

C. The lift check valve body, and cap shall be leaded bronze ASTM B 763. Disc shall be special composition, as best suited for petroleum service condition. The disc shall be secured to the disc by means of a disc retaining nut. To protect against leakage on light oils and gases, the disc shall be sealed into the holder. The union cap shall provide a tight joint, easily dismantled when necessary. They shall have screwed connections. The valves shall be suitable for a maximum working non-shock pressure of 400 psi cold water, oil, gas, LP gases, and volatile fluids.

D. Manufacturers, or Equal
   1. Crane

2.7 PLASTIC SWING OR WYE-CHECK VALVES

A. General: Plastic swing or wye-check valves for corrosive fluids, in sizes up to 8-inches or as available, may be used for horizontal or vertical up-flow conditions.

B. Construction: The valve bodies and discs or piston shall be of PVC, PP, or PVDF construction as best suited for each individual service condition. They shall have flanged ends conforming to ASME B16.5 Class 150, and flanged top access covers and shall shut positively at no-flow conditions. The seats and seals shall be of EPDM, Teflon, or Viton. The PVC valves shall be rated for a maximum non-shock working pressure of 150 psi at 73 degrees F for sizes 3-inches and smaller. For larger sizes and other materials and temperatures the pressure rating may be lower.

C. Manufacturers, or Equal
   1. ASAHI-AMERICA
   2. George Fischer, Inc.
   3. Spears Mfg. Co. (Plastic Swing Check only)

PART 3 - EXECUTION

3.1 GENERAL

A. Valves shall be installed in accordance with provisions of Section 40 05 51 - Valves, General.

END OF SECTION

SECTION 40 05 69
PRESSURE REDUCING VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide pressure reducing valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 - Valves, General, apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures and 40 05 51 – Valves, General, including a cavitation study from the valve manufacturer.

PART 2 - PRODUCTS

2.1 GENERAL

A. Function: Pressure reducing valves shall reduce an upstream pressure to a pre-set constant lower pressure, regardless of fluctuations in the upstream pressure.

B. Operation: The valves shall be hydraulically-operated, with diaphragm or piston direct action, pilot-controlled, per paragraph 2.2, and shall be of the globe or angle pattern as indicated. Necessary repairs shall be possible without removing the valves from the pipeline. The smaller direct-acting valves with threaded ends per paragraph 2.3, shall be suitable for water or air service and shall be of the globe pattern.

2.2 FLANGED VALVES, SIZES 1-1/2 INCHES THROUGH 42-INCHES

A. Valve Body: The valve body shall be of cast iron to ASTM A 48 - Gray Iron Castings, or ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with 125 lb flanged ends to ANSI/ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800. The valve cover shall be flanged and be the same material as the body.

B. Valve Trim: The valve stems with position indication, springs, body seat rings, and bolts, nuts, and washers shall be of Type 302, 303, or 316 stainless steel. The valve stems shall have top and bottom guides. Rubber parts shall be Buna-N. The diaphragms shall be of Nylon-reinforced Buna-N, supported firmly between body and valve cover. The valve pistons and piston liners shall be bronze to ASTM B 62 - Composition Bronze or Ounce Metal Castings.

C. Valve Controls: The valve shall be provided with a complete, externally mounted control system, including speed control needle valves, strainers, check valve, isolation valves, and necessary copper or stainless steel connecting tubing and fittings. The controls shall be capable of achieving the flow and speed adjustment indicated.

D. Factory Tests and Warranty: Valves shall be factory tested with a hydrostatic test and a functional test and a test certificate shall be submitted to the Engineer prior to delivery of the valve. The valve shall be warranted for a period of 3 years from the date of shipment to be free of defects in materials and workmanship.

E. Operating Conditions: The valves shall be designed to operate under the conditions as specified in the specific equipment specification or as identified in the Contract P&ID drawings.

F. Spare Parts: The following spare parts shall be furnished in accordance with Section 40 05 51 – Valves, General:
   1. One set of all resilient seals and discs
   2. One diaphragm (for diaphragm valves, only)

G. Manufacturers, or equal
   1. Cla-Val Company
   2. OCV Control Valves
   3. Ross Valve Mfg. Co., Inc.
   4. Singer Valve, Inc.
   5. Watts, ACV

2.3 THREADED VALVES, SIZES 1/2 TO 2-1/2 INCHES

A. Valve Body: The valve body shall be bronze to ASTM B 62 or cast steel, with a minimum pressure rating of 300 psi, and with threaded ends. The valve shall be provided with an integral or an attached strainer with access cap or plug and a flanged or threaded valve cover. The valve shall be actuated by a diaphragm or piston.

B. Valve Trim: The valve stems, springs, body seats, and washers shall be of Series 300 stainless steel. The strainers shall be of stainless steel or monel and the diaphragms shall be of reinforced neoprene. The valve pistons and piston liners shall be bronze to ASTM B 62.

C. Operating Conditions: The valves shall be designed to operate under the conditions as specified in the specific Division 11 equipment specification or as identified in the Contract P&ID drawings.

D. Spare Parts: The following spare parts shall be furnished in accordance with Section 40 05 51 – Valves, General:
   1. One complete set of resilient seals and discs
   2. One diaphragm (for diaphragm valves, only)

E. Manufacturers, or equal
   1. Cla-Val Company
   2. Fisher Controls
   3. GA Industries
   4. Watts, ACV
   5. Wilkins Regulator Div. (Zurn Industries)

2.4 PLASTIC VALVES, SIZES 1/4 TO 2 INCHES

A. Plastic pressure reducing valves shall be designed for not less than 150 psi water working pressure and shall be suitable for the fluid service. For chemicals and corrosive fluids, solenoid valves shall be PVC, CPVC, polypropylene (PP), polyvinylidene fluoride (PVDF), or teflon materials of construction as recommended by the manufacturer for the specific application.

B. Characteristics: Valves shall open when the outlet pressure drops below a set minimum value, and maintain the pressure and open wide as flow requirements dictate. Valves shall be spring- or hydraulically-operated, direct acting, adjustable, diaphragm or piston type as indicated.

C. Manufacturers, or equal
   1. Corrosive Fluids
   2. Plast-O-Matic Valves, Inc.
   3. George Fisher

PART 3 - EXECUTION

3.1 INSTALLATION

A. Valves shall be installed in accordance with provisions of Section 40 05 51 – Valves, General.

3.2 SERVICES OF MANUFACTURERS (FOR VALVES LARGER THAN 8")

A. Inspection, Startup, and Field Adjustment: The service representative of the valve manufacturer shall be present at the Site for 1-Day, to assist the Contractor in the installation and adjustment of the valve(s).

B. Instruction of Owner's Personnel: The training representative of the valve manufacturer shall be present at the Site for 1-Day to instruct the personnel in the operation, adjustment, and maintenance of the valve(s).

C. For the purpose of this paragraph, a Day is defined as an 8 hour period, excluding travel time.

END OF SECTION

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SECTION 40 05 70
PRESSURE RELIEF VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide pressure relief valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 - Valves, General, apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51.

1.3 SPECIAL WARRANTY REQUIREMENT

A. The valve shall be warranted for a period of 3 years from the date of shipment to be free of defects in materials and workmanship.

PART 2 - PRODUCTS

2.1 THREADED PRESSURE RELIEF VALVES, SIZES 1/2- THROUGH 2.5 INCHES

A. Valve Characteristics: The pressure relief valve shall open when the inlet water pressure exceeds a set maximum level. It shall maintain that pressure and gradually close as the pressure drops below the maximum pressure. The valve shall be a spring and hydraulically-operated, direct-acting, adjustable diaphragm or piston type globe or angle valve as indicated.

B. Valve Body: The valve body shall be bronze with threaded inlet and outlet to standard NPT and with flanged top, suitable for an inlet pressure of 300 psi. The spring shall be adjustable with an adjusting screw, to regulate the pressure setting.

C. Valve Trim: The valve trim shall be of stainless steel or bronze with stainless steel spring. The rubber seat shall be replaceable.

D. Pressure Setting: The valve shall be set for a relief pressure as directed by Engineer.

E. Manufacturers, or equal
   1. Cla-Val Company
   2. Golden-Anderson
   3. Ross Valve Mfg. Co., Inc.

2.2 FLANGED PRESSURE RELIEF VALVES, SIZES SMALLER THAN 42-INCHES

A. Valve Body: The valve body shall be of cast iron to ASTM A 48 - Gray Iron Castings, or ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with 350 lb flanged ends to

ANSI/ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800. The valve cover shall be flanged and be the same material as the body.

B. Valve Trim: The valve stems with position indication, springs, body seat rings, and bolts, nuts, and washers shall be of Type 302, 303, or 316 stainless steel. The valve stems shall have top and bottom guides. Rubber parts shall be Buna-N. The diaphragms shall be of Nylon-reinforced Buna-N, supported firmly between body and valve cover. The valve pistons and piston liners shall be bronze to ASTM B 62 - Composition Bronze or Ounce Metal Castings.

C. Valve Controls: The valve shall be provided with a complete, externally mounted control system, including speed control needle valves, strainers, check valve, isolation valves, and necessary stainless steel connecting tubing and fittings. The controls shall be capable of achieving the flow and speed adjustment indicated.

D. Orifice Plate: Pressure Relief Valve PRV-3804 as listed in the equipment schedule is to have a stainless steel removable orifice plate with an orifice of diameter no larger than 1-7/8" to allow no more than 1,000 gpm through the orifice at the maximum operating pressure.

E. Factory Tests and Warranty: Valves shall be factory tested with a hydrostatic test and a functional test and a test certificate shall be submitted to the Engineer prior to delivery of the valve. The valve shall be warranted for a period of 3 years from the date of shipment to be free of defects in materials and workmanship.

F. Operating Conditions: The valves shall be designed to operate under the conditions as specified in the specific equipment specification or as identified in the Contract P&ID drawings.

G. Manufacturers, or equal
1. Cla-Val Company
2. OCV Control Valves
3. Ross Valve Mfg. Co., Inc.
4. Singer Valve, Inc.

2.3 TEMPERATURE AND PRESSURE RELIEF VALVES

A. Valve Construction: Temperature and pressure relief valves for cold and hot water, steam, and air service, unless otherwise indicated, shall have a minimum pressure rating of 250 psi; bronze, steel, or stainless steel bodies; adjustable spring action; screwed or flanged connections; and trim to suit individual applications. Settings shall be adjusted for each specific condition.

B. Manufacturers, or Equal
1. A.W. Cash Valve Mfg. Corp.
2. Consolidated (Dresser Industries Valve Division)
3. Fisher Controls Company
4. Kunkle Valve Division
5. Masoneilan (Dresser Industries Valve and Controls Division)
6. Watts Regulator Company
7. Wilkins Regulator (A Division of Zurn Industries)

2.4 PLASTIC PRESSURE RELIEF VALVES, SIZES 1/2- THROUGH 1-1/2 INCHES

A. Plastic pressure relief valves shall be suitable for the fluid service and shall be designed for a maximum of 150 psi water working pressure. For chemicals and corrosive fluids, pressure relief valves shall be of PVC, CPVC, polypropylene (PP), polyvinylidene fluoride (PVDF), or teflon, as recommended by the manufacturer for the specific application.

B. Characteristics: Pressure relief valves shall open when the inlet pressure exceeds a set maximum level. It shall maintain that pressure and gradually close as the inlet pressure drops below the maximum pressure. Valves shall be spring or hydraulically-operated, direct acting, adjustable diaphragm or piston type globe or angle valve, as indicated.

C. Manufacturers, or equal
   1. Corrosive fluids
      a. Plast-O-Matic Valves, Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Valves shall be installed in accordance with provisions of Section 40 05 51.

END OF SECTION

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SECTION 40 05 74
DIAPHRAGM VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide manually operated diaphragm valves including appurtenances and accessories, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 - Valves, General apply to this Section.

C. The requirements of Section 40 05 52 - Valve and Gate Actuators apply to this Section.

D. The requirements of Section 46 33 00 - Chemical Feeding Equipment, General apply to this Section.

1.2 SUBMITTAL PROCEDURES

A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures and 40 05 51 - Valves, General.

PART 2 - PRODUCTS

2.1 GENERAL DIAPHRAGM VALVE REQUIREMENTS

A. Construction: Diaphragm valves shall be of the weir type, unless otherwise indicated, and be of the material combination best-suited for each individual application. They shall be suited for bi-directional throttling service and installation in any position, with bubble-tight shut-off. Valves on outlets and drain nozzles of storage tanks shall be lined metal bodies.

B. Actuators: Unless otherwise indicated, all diaphragm valves shall have manual hand-wheel actuators with position indicators and transparent plastic stem covers of clear acrylic, polycarbonate, or similar material. Valve actuators shall be in accordance with Section 40 05 52 – Valve and Gate Actuators. The handwheels shall be of cast-iron, aluminum, or polypropylene.

2.2 METAL BODY DIAPHRAGM VALVES

A. Construction: The valve body shall be of cast-iron to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, Class B, or of ductile iron to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures, PVC lining. The valve ends shall be flanged to ANSI/ASME B16.1 Pipe Flanges and Flanged Fittings, 125-pound rating, or screwed, as indicated. The valve bonnet shall be steel, with brass or bronze sleeve and a compressor of aluminum, brass, bronze, or cast-iron. The bolts and nuts shall be of stainless steel and the stem and bonnet seals of Viton O-rings.

B. Diaphragm: Unless otherwise recommended by the manufacturer, the diaphragm material shall be Teflon. All diaphragms shall be of rugged, reinforced construction, be oil resistant, and be designed for long life.

C. Manufacturers, or approved equal
   1. ITT Dia-Flo (Grinnell);
   2. McCanna, Inc.

2.3 PLASTIC BODY DIAPHRAGM VALVES

A. Construction: Unless otherwise indicated, valve bodies shall be of PVC construction with union ends, screwed ends, socket-welded ends, or flanged ends to ANSI/ASME B16.1 - drilled to 125-pound dimensions, as indicated. The valve bonnets shall be flanged and of PVC construction. The valve stem shall be of carbon steel or stainless steel with brass, bronze, or cast-iron sleeve and a compressor of aluminum, brass, bronze, or cast-iron. The bolts, nuts, and washers shall be of stainless steel and the stem and bonnet seals of Viton or Buna-N O-rings. Valves in sizes 1/2-inch through 4-inch shall have a pressure rating of 150 psi at 104 degrees F.

B. Diaphragm: Unless otherwise recommended by the manufacturer, the diaphragm material shall be Teflon. All diaphragms shall be of rugged, reinforced construction, be oil resistant, and be designed for long life.

C. Manufacturers, or approved equal
   1. ASAHI/America
   2. George Fisher, Inc. (+GF+)
   3. ITT Dia-Flo (Grinnell)
   4. McCanna, Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Valves shall be installed in accordance with Section 40 05 51 - Valves, General. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

B. Install diaphragm valves in all chlorine solution and chemical feed lines, between the appropriate storage tanks and points of application, and where indicated, in strict accordance with the manufacturers published recommendations.

END OF SECTION

SECTION 40 61 00
INSTRUMENTATION SYSTEMS GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. General requirements applicable to all process control and instrumentation systems (PCIS) work.
2. The requirements of this section apply to all components of the PCIS unless indicated otherwise.
3. General requirements for process control and instrumentation (PCI) submittals.

B. Related sections:
1. The contract documents are a single integrated document, and as such all divisions and sections apply. It is the responsibility of the contractor and its subcontractors to review all sections to ensure a complete and coordinated project:
   a. Items involving electrical, control, and instrumentation construction may be shown on drawings or referred to in specifications that do not apply specifically to electrical, control and instrumentation systems.

C. PCIS work and responsibility shall be as follows:
1. Contractor – The Contractor is responsible for the overall plant PCIS. The Contractor shall coordinate the procurement and installation of all PCIS equipment per the Contract Documents.
2. Vendor – Each Vendor shall be responsible to provide PCIS in accordance with the Drawings and Specifications. The Vendor will provide all control panels including all PLC hardware, I/O, HMI, networking hardware, software, and associated process instrumentation required for their process and as indicated in the Drawings and Specifications. Each Vendor is responsible for programming of their PLC panel and HMI. Each Vendor shall adhere to tag numbers as shown on the Drawings to facilitate plant SCADA integration.
3. AWC - The pre-purchase water treatment equipment PCIS is the responsibility of AWC. All PCIS equipment to be supplied under the AWC pre-purchase contract shall programmed by AWC, including all PLC's and HMI's. AWC shall adhere to tag numbers as shown on Drawings to facilitate plant SCADA integration.
4. Integrator – The Owner has pre-selected SKM Engineering as the Integrator. The Integrator is responsible to provide all control panel hardware and software not provided in Vendor packages or by AWC. The Integrator shall be responsible to provide all control panels including all PLC hardware, I/O, HMI, networking hardware, and software as indicated in the Drawings and Specifications. The Integrator will also be responsible for all non-HMI SCADA integration, including all hardware and software. The Contractor is responsible for the installation of all control panels provided by the Integrator.

D. Interfaces to Equipment, Instruments, and Other Components:
   1. The drawings, specifications and overall design are based on preliminary information furnished by various equipment manufacturers which identify a minimum scope of supply from the manufacturers. This information pertains to, but is not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.
   2. Provide all material and labor needed to install the actual equipment furnished, include all costs to add any additional instruments, wiring, control system inputs/outputs, controls, interlocks, electrical hardware etc., which may be necessary to make a complete, functional installation based on the actual equipment furnished. Make all changes necessary to meet the manufacturer's wiring requirements.
   3. Submit all such changes and additions to the Engineer for acceptance in accordance with the General Conditions.
   4. Review the complete set of drawings and specifications in order to ensure that all items related to the instrumentation and control systems are completely accounted for. Include any items that appear on drawings or in specifications from another discipline in the scope of work. If a conflict between drawings and specifications is discovered, refer conflict to the Engineer as soon as possible for resolution.
   5. Provide complete loop drawings for all systems, including packaged equipment furnished as part of a vendor furnished package, and for all pre-purchased equipment.

E. All instrumentation, control equipment and systems for the entire project is to comply with the requirements of Division 40, whether referenced in the individual equipment specifications or not:
   1. The requirements of Division 40 apply to all instrumentation and control work specified in other Specifications, including HVAC controls, packaged mechanical systems, LCPs, VCPs, etc.
   2. Inform all vendors supplying instrumentation, control systems, panels, and/or equipment of the requirements of Division 40.
   3. The owner is not responsible for any additional costs due to the failure of the contractor to notify all subcontractors and suppliers of the Division 40 requirements.

F. Contract Documents:
   1. General: Contract documents consist of drawings, specifications, and other documents issued by the Engineer. The drawings and specifications are complementary and are to be used together in order to fully describe the work and requirements shown written or reasonably inferred on one form is considered as written, shown or implied in all. In the event work is called for in more than one place and there are conflicting requirements, the right shall be reserved to require the installation of the larger or the more expensive.
   2. Specifications:
      a. The General and Supplementary Conditions of the contract documents govern the work.
      b. These requirements are in addition to all General Requirements.
   3. Contract Drawings:
      a. The instrumentation and control drawings show in a diagrammatic manner, the desired locations, and arrangements of the components of the instrumentation work. Follow the drawings as closely as possible, use professional judgment and coordinate with the other trades to secure the best

possible installation, use the entire drawing set for construction purposes. Contractor is to verify all dimensions given on the drawings, and to report any discrepancy or inconsistency to the Engineer before commencing with the work.

b. Locations of equipment, control devices, instruments, boxes, panels, etc. are approximations only. Exercise professional judgment in executing the work to ensure the best possible installation:
   1) The equipment locations and dimensions shown on plans and elevations are approximations. Use the shop drawings to determine the proper layout, foundation, and pad requirements, etc. for final installation. Coordinate with all subcontractors and all disciplines to ensure that all instrumentation and control equipment is compatible with other equipment and space requirements. Make and workout changes required to accommodate differences in equipment dimensions.
   2) The contractor has the freedom to select from among the named manufacturers of equipment as identified in the individual specification sections. However, the Engineer has typically designed the spatial equipment layout based upon one manufacturer and has not confirmed that every named manufacturer's equipment fits in the allotted space. It is the contractor's responsibility to ensure that the equipment being furnished fits within the defined space and works with the provided infrastructure.

c. Installation Details:
   1) The contract drawings include installation details indicating means and methods the contractor is to use to install instrumentation and control equipment. For cases where a typical detail does not apply, develop installation details that necessary for completing the work, and submit these details for discussion with, review and approval by the Engineer.

d. Schematic Diagrams:
   1) All controls are shown in the de-energized state unless otherwise noted.
      a) Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.
      b) Add slave relays, where required, to provide all necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination or control system voltage drop considerations.
      c) Mount all devices shown on motor controller schematic diagrams in the controller compartment enclosure unless otherwise noted or indicated.
      d) Control schematics are to be used as a guide in conjunction with the descriptive operating sequences found in the drawings and/or specifications. Combine all information and furnish a coordinated and fully functional control system.

4. Alternates/Alternatives: Refer to the General Conditions for substitute item provisions.
5. Changes and Change Orders: Refer to the General Conditions.

1.2 REFERENCES

A. Code Compliance:
1. As specified in Section 01 42 19 – Reference Standards.
   a. The publications are referred to in the text by basic designation only. The latest edition accepted by the authority having jurisdiction of referenced publications in effect at the time of bid governs.
2. The following codes and standards are hereby incorporated into these specifications:
   a. National Fire Protection Association (NFPA):
      1) NFPA 70 - National Electric Code (NEC).
      2) NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
      3) NFPA 496 - Purged and Pressurized Enclosures for Electrical Equipment, where applicable.
      4) NFPA 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
   b. Underwriters Laboratories, Inc. (UL):
      1) UL 508A - Industrial Control Equipment.
      2) UL 698A – Industrial Control Equipment in hazardous locations.
   c. American National Standards Institute (ANSI):
      1) ANSI B16.5 - Pipe Flanges and Flanged Fittings.
   d. American Petroleum Institute (API):
      1) API RP551 - Process Measurement Instrumentation.
      2) API RP552 - Transmission Systems.
      3) API RP553 - Refinery Control Valves.
      4) API RP554 - Process Instrumentation and Control.
      5) API RP555 - Process Analyzers.
      6) API RP556 - Fired Heaters & Steam Generators.
      7) API RP557 - Guide to Advanced Control Systems.
   e. American Society of Testing and Materials (ASTM):
      1) ASTM A269 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   f. Instrumentation, Systems, and Automation Society (ISA):
      1) ISA-5.1 - Instrumentation Symbols and Identification.
      2) ISA-5.2 - Binary Logic Diagrams for Process Operations.
      3) ISA-5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
      4) ISA-5.4 - Instrument Loop Diagrams.
      5) ISA-5.5 - Graphic Symbols for Process Displays.
      6) ANSI/ISA-7.00.01 - Quality Standard for Instrument Air.
      7) ISA-RP - 12.4 - Pressurized Enclosures.
      8) ANSI/ISA-18.1 - Annunciator Sequences and Specifications.
      9) ISA-20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.

10) ISA-TR20.00.01 - Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2005.
11) ANSI/ISA-50.00.01 - Compatibility of Analog Signals for Electric Industrial Process Instruments.
12) ISA-51.1 - Process Instrumentation Terminology.
13) ISA-RP60.3 - Human Engineering for Control Centers.
14) ISA-71.01 - Environmental Conditions for Process Measurement and Control Systems: Temperature and Humidity.
15) ISA-71.02 - Environmental Conditions for Process Measurement and Control Systems: Power.
16) ISA-71.03 - Environmental Conditions for Process Measurement and Control Systems: Mechanical Influences.
17) ISA-71.04 - Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants.

B. Compliance with Laws and Regulations:
1. Refer to the General Conditions.

C. Project or Site Conditions:
1. Refer to site conditions Section 26 00 00 to ensure all equipment and instrumentation provided meets site conditions.

1.3 DEFINITIONS

A. Definitions of terms and other electrical and instrumentation considerations as set forth in the:
1. NEC: National Electrical Code.
2. IEEE: Institute of Electrical and Electronic Engineers.
3. ISA: Instrumentation, Systems, and Automation Society.
4. NFPA: National Fire Protection Association.
5. NETA: National Electrical Testing Association.

B. Specific Definitions:
1. Control Circuit: Any circuit operating at 120VAC/VDC or less, whose principal purpose is the conveyance of information (including performing logic) and not the conveyance of energy for the operation of an electrically powered device.
2. Panel: An instrument support system that may be either a flat surface, a partial enclosure or a complete enclosure for instruments and other devices used in process control systems. Unless otherwise specified or clearly indicated by the context, the term “panel” in these contract documents is interpreted as a general term, which includes flat surfaces, enclosures, cabinets and consoles.
3. Power Circuit: Any circuit operating at 90 Volts (AC or DC) or more, whose principal purpose is the conveyance of energy for the operation of an electrically powered device.
4. Signal Circuit: Any circuit operating at less than 50 Volts (AC or DC) which conveys analog information or digital communications information.

5. Digital Bus: A communication network, such as Ethernet, Ethernet/IP, Modbus, Profibus, Foundation Fieldbus, ControlNet or DeviceNet, allowing instruments and devices to transmit data, control functions and diagnostic information.
6. 2-Wire Transmitter (loop-powered): A transmitter that derives its operating power supply from the signal transmission circuit and requires no separate power supply connections. As used in this specification, two-wire transmitter refers to a transmitter that provides 4-20mA current regulation of a signal in a series circuit with an external 24VDC driving potential.
    a. Can be Field-bus communications signal, 4-20mA signal or both.
7. Powered Transmitters: A transmitter that requires a separate power source (120VAC, 240VAC, 24VDC etc.) in order for the transmitter to develop its signal. As used in this Specification, the produced signal may either be a 4-20mA current signal, a digital bus communications signal or both.
8. Modifications: Changing, extending, interfacing to, removing or altering an existing circuit.

C. Acronym Definitions:
1. ES: Enterprise System; PC-based communications or data sharing system utilized for non-process control functions such as E-mail, sharing files, creating documents, etc.
2. FAT: Factory Acceptance Test.
3. HOA: Hand-Off-Auto; control function that is totally PLC-based. In the Hand mode of control equipment is manually started or stopped, valves are opened or closed through operator direction under the control of the PLC software. In the Auto mode of control equipment is started or stopped, valves are opened or closed through a control program or algorithm within the PLC software. In the Off mode the equipment is prohibited from responding from the PLC control.
4. HMI: Human Machine Interface; operator interface device consisting of an alphanumeric display and operator input devices. The HMI is typically a flat panel type of display with either a touch screen or tactile button interface.
5. HVAC: Heating, Ventilation, & Air Conditioning.
6. ICSC: Instrumentation and Control System Contractor; subcontractor who specializes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems.
7. IJB: Instrument Junction boxes; a panel designed with cord sets to easily remove, replace or relocate instrument signals.
8. I/O: Input/Output.
9. LCP: Local Control Panel; operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and may or may not contain a PLC or RIO.
10. LAN: Local Area Network; a control or communications network that is limited to the physical boundaries of the facility.
11. LOR: Local-Off-Remote; control function that usually allows for locally/manually control of the attached equipment. In the Remote mode equipment is started or stopped, valves are opened or closed through the PLC-based upon the selection of the HOA. In Local control, equipment is started or stopped, valves are opened or closed based upon hardwired control circuits completely independent of the PLC with

minimum interlocks and permissive conditions. In the Off mode, the equipment is prohibited from responding to any control commands.

12. OIT: Operator Interface Terminal; PC-based interface device used for operator interface with the controls network and/or SCADA system.
13. P&ID: Process and Instrumentation Diagram.
14. PC: Personal Computer.
15. PCIS: Process Control and Instrumentation System; includes the entire instrumentation system, the entire control system and all of the work specified in Division 40 and depicted on the P&IDs.
16. PCM: Process Control Module; an enclosure containing any of the following devices: PLC, RIO or network devices.
17. PJB: Power Junction Box; an enclosure with terminal blocks that distribute power to multiple instruments or controls devices.
18. PLC: Programmable Logic Controller.
19. RIO: Remote I/O; devices for connection to the PLC consisting of remote I/O racks or remote I/O blocks.
20. RTU: Remote Telemetry Unit; a controller typically consisting of a self-contained controller (CPU) and has means for remote communications. The remote communications devices typically are radios, modems, communication networks etc.
21. SCADA:Supervisory Control and Data Acquisition; a system or network that consists of the computer-based software package that includes the operator interface, data storage, data retrieval, archiving, alarming, historian, reporting, trending, and other higher level control system software.
22. UPS Uninterruptible Power Supply.
23. VCP: Vendor Control Panel; a control panel that is/are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, OIT, HMI, etc.
24. WAN: Wide Area Network; a control or communications network that extends beyond the physical boundaries of the facility usually by means of radios, modems and other communication equipment.

1.4 SYSTEM DESCRIPTION

A. General Requirements:

1. The work includes everything necessary for executing and completing the general requirements for the instrumentation and control system work described in the contract drawings and specifications and reasonably inferable there from including but not limited to:
    a. Preparing hardware submittals for field instrumentation.
    b. Design, develop, and draft loop drawings, control panel designs, and all other drawing submittals specified in Division 40.
    c. Prepare the test plan, the training plan, and the spare parts submittals.
    d. Procure all hardware.
    e. Provide PCIS system hardware and software.
    f. Fabricate panels.
    g. Perform factory acceptance test(s) on panels.
    h. Perform bench calibration and verify calibration after installation.
    i. Oversee and certify installation of the PCIS system.
    j. Oversee, document, and certify loop testing.

k. Oversee, document, and certify system pre-commissioning.
l. Conduct the required performance tests.
m. Prepare Operation and Maintenance Manuals (O&MMs).
n. Conduct training classes.
o. Prepare record drawing packages.
p. Integrate the PCIS with instrumentation and control devices provided under other sections as specified.
q. Develop all requisite loop drawings and record drawings associated with equipment provided under other divisions of these specifications and (as specified) owner furnished and existing equipment.
r. Resolve signal, power, or functional incompatibilities between the PCIS and interfacing devices.
s. Perform all required corrective and preventative maintenance.

2. It is the intent of these specifications that the entire electrical power, instrumentation, and control system be complete and operable. Provide all necessary material and labor for the complete system from source of power to final utilization equipment, including all connections, testing, calibration of all equipment furnished by others as well as equipment furnished by the contractor, as specifically mentioned and which are necessary for complete and successful operation.
3. Provide the complete operating PCIS to perform the specified monitoring, communications, alarm, control, display, and reporting functions in accordance with the requirements of the contract documents.
4. Coordinate all aspects of the work with the ICSC before bidding to ensure that all costs associated with a complete installation are included. The owner is not responsible for any change orders due to lack of coordination of the work between the contractor, the ICSC, and the other subcontractors and/or suppliers.
5. Furnish detailed, complete and thorough operations and maintenance documentation; including, but not limited to operations manuals, maintenance manuals, as-built wiring drawings, training manuals, as-built software documentation, vendor-supplied software documentation, final as-installed software configurations and all other documentation required to operate, modify and maintain all parts of the PCIS.
6. Where demolition is shown on any drawing, the electrical subcontractor is responsible for disconnecting equipment electrical connections and rendering the equipment safe. The ICSC is responsible for physically removing all instrumentation to be demolished and return it either to the Owner or dispose of it as directed by the owner's representative. The ICSC shall be responsible for any program modifications required based on the demolition of the equipment; both for the loops directly and indirectly affected.
7. Portions of this project <u>may</u> involve installation in existing facilities and interfaces to existing circuits, power systems, controls, and equipment:
    a. Perform and document comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc.) <u>before</u> performing any work.
    b. Provide and document any interface with, modifications to, upgrade to or replacement of existing circuits, power systems, controls and equipment.
8. Revise in a manner as directed by the Engineer all I/O and addressing that the Engineer determines to be unacceptable as a result of a lack of contractor coordination between contract documents and all subcontractors and/or suppliers.

9. Defective Work:
    a. Refer to the General Conditions.

B. System Overview: The new PCIS shall include but not be limited to the following:
    1. Control Panels to be furnished for the PCIS shall include, but may not be limited to:

Facility	Panel tag	Description	Supplied by	Installed by	Reference Specification	PLC Programming By
TREATMENT PLAN	LCP-1000	SCADA PLC	INTEGRATOR	CONTRACTOR	40 63 43, 40 63 44, 40 78 00	INTEGRATOR
	LCP-1101	TREATMENT PLC	AWC	CONTRACTOR	PRE-PURCHASE	AWC
	LCP-1201	TREATMENT RIO	AWC	CONTRACTOR	PRE-PURCHASE	AWC
	LCP-1301	TREATMENT RIO	AWC	CONTRACTOR	PRE-PURCHASE	AWC
	LCP-1401	TREATMENT RIO	AWC	CONTRACTOR	PRE-PURCHASE	AWC
	LCP-1974	MICROCHLOR	VENDOR	CONTRACTOR	46 35 50	VENDOR

    2. All non-HMI SCADA hardware, software, and programming by Integrator.

C. General:
    1. Furnish submittals that are fully developed for a given section of the work and fully indexed with a tabbed divider for every element and component.
    2. Sequentially number the pages within the tabbed sections. Submittals and Operation and Maintenance Manuals (O&MMs) that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
    3. Edit all submittals and O&MMs so that the submittal specifically applies to only the equipment furnished. Neatly cross out all extraneous text, options, models, etc. that do not apply to the equipment being furnished so that the information remaining is only applicable to the equipment being furnished.
    4. Instruct all equipment suppliers of submittal and O&MMs in the requirements of Section 40 61 00 - Process Control and Instrumentation Systems, General.
    5. Submittal Requirements:
        a. Submit copies of shop drawings, and product data, in accordance with Section 01 33 20 – Contractor Submittals in addition to the requirements of this section. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.
        b. Where submittals are required, provide a separate submittal for each specification section. In order to expedite construction, the contractor may make more than one submittal per specification section, but a single submittal may not cover more than one specification section. The only exception to this requirement is when one specification section covers the requirements for a component of equipment specified in another section.
    6. Exceptions to specifications and drawings:
        a. Include a list of proposed exceptions to the specifications and drawings along with a detailed explanation of each.
        b. Any exceptions to the specification and drawings must be noted and the reason for the exception explained.
        c. If there is insufficient explanation for the deviation, the submittal will be returned requiring revision and re-submittal.

d. Acceptance of any exception is at the sole discretion of the Engineer. Furnish all items (materials, features, functions, performance, etc.) that are not listed as exceptions strictly in accordance with the specifications and drawings.

e. Replace all items that do not strictly meet the requirements of the specifications, which were not previously accepted as exceptions, even if the submittals contained information indicating the failure to meet the requirements.

7. Submittal Organization:

a. First page:

1) Specification Section reference.

2) Name and telephone number of individual who reviewed submittal before delivery to Engineer.

3) Name and telephone number of individual who is primarily responsible for the development of the submittal.

4) Place for contractor's review stamp and comments.

b. Next pages:

1) Provide confirmation of specification compliance in a tabular form that individually lists each specification section, paragraph, and sub-paragraphs and unequivocally states compliance with said requirement or takes exception to the requirement and lists the reason for said exception and offers alternative means for compliance.

2) Include a response in writing to each of the Engineer's comments or questions for submittal packages which are re-submitted:

a) In the order that the comments or questions were presented throughout the submittal.

b) Referenced by index section and page number on which the comment appeared.

c) Acceptable responses to Engineer's comments are either:

d) Engineer's comment or change is accepted and appropriate changes are made.

e) Explain why comment is not accepted or requested change is not made.

f) Explain how requirement will be satisfied in lieu of comment or change requested by Engineer.

g) Any re-submittal, which does not contain responses to the Engineer's previous comments, shall be returned for revision and re-submittal.

h) No further review by the Engineer will be performed until a response for previous comments has been received.

c. Remaining pages:

1) Actual submittal data:

a) Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the specification section.

b) For submittals that cover multiple devices used in different areas under the same specification section, the submittal for the individual devices must list the area where the device is intended to be used.

d. Specific submittal requirements:

1) Furnish the submittals required by each section or Division 27:
   a) Product Data.
   b) Shop Drawings.
2) Use equipment and instrument tags as depicted on the P&IDs for all submittals.
3) Adhere to wiring numbering scheme outlined in Division 26 throughout the project:
   a) Uniquely number each wire per the specifications.
4) Wire numbers must appear on all equipment drawings.

e. In these contract documents, some items of work are represented schematically, and are designated for the most part by numbers, as derived from criteria in ANSI/ISA S5.1:
   1) Employ the nomenclature and numbers designated herein and on the drawings exclusively throughout shop drawings, data sheets, and similar submittals.
   2) Replace any other symbols, designations, and nomenclature unique to a manufacturer's, suppliers, or subcontractor's standard methods with those identified herein and on the drawings.

f. Furnish submittals in the following general order, each in a separate bound set:
   1) Product Data.
   2) After approval of the Product Data, submit the Project Shop Drawing submittals
   3) Testing, Calibration and Start-up procedures.
   4) Operation and Maintenance Data.
   5) Training Submittals.
   6) Record Documents.

D. Product Data:
   1. General:
      a. Submitted for non-custom manufactured material listed in this and other sections and shown on shop drawings.
      b. Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these specifications.
      c. Include:
         1) Catalog cuts.
         2) Bulletins.
         3) Brochures.
         4) Quality photocopies of applicable pages from these documents.
         5) Identify on the data sheets the project name, applicable specification section, and paragraph.
         6) Identify model number and options for the actual equipment being furnished.
      d. Neatly cross out options that do not apply or equipment not intended to be supplied.
   2. Material and Equipment Schedules:
      a. Furnish a complete schedule and/or matrix of all materials, equipment, apparatus, and instruments that are proposed:

b. Include sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.

3. Instrument Data Sheets and Cut Sheets:
   a. Provide fully completed data sheets, both electronically in Microsoft Word or Excel and in hardcopy, for each instrument and component according to ISA S20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves. Include the following information on the data sheet:
      1) Component functional description used herein and on the drawings.
      2) Manufacturers model number or other product designation.
      3) Tag number used herein and on the drawings.
      4) System or loop of which the component is a part.
      5) Location or assembly at which the component is to be installed.
      6) Input and output characteristics.
      7) Scale range and units and multiplier.
      8) Requirements for electric supply.
      9) Requirements for air supply.
      10) Materials of construction and of component parts that are in contact with, or otherwise exposed to, process media, and or corrosive ambient air.
      11) Special requirements or features, such as specifications for ambient operating conditions.
      12) Features and options that are furnished.
   b. Provide a technical brochure or bulletin ("cut sheet") for each instrument on the project. Submit with the corresponding data sheets:
      1) Where the same make and model of instrument is used in two or more applications on the project, and the process applications are nearly identical, and the materials, features and options are identical submit one brochure or bulletin for the set of identical instruments.
      2) Include a list of tag numbers for which it applies with each brochure or bulletin.
      3) Furnish technical product brochures that are complete enough to verify conformance with all contract document requirements, and to reflect only those features supplied with the device.
      4) Cross out models, features, options, or accessories that are not being provided.
      5) Clearly mark and identify special options and features.
   c. Organization: Index the data sheets and brochures in the submittal by systems or loops.

4. Control Panel Hardware Submittal:
   a. Submit the following in one submittal package.
   b. Complete and detailed bills of materials:
      1) Including quantity, description, manufacturer and part number for each assembly or component for each control panel.
      2) Include all items within an enclosure.
   c. Complete grounding requirements for each system component including any requirements for PLCs, process LANs and SCADA equipment.
   d. Requirements for physical separation between control system components and 120VAC, 480VAC and medium voltage power cables.

e. UPS and battery load calculations to show that the backup capacity and time meet the specified requirements.

f. Heat Dissipation in Enclosures calculations with proposed equipment to dissipate and resolve heat rise issues within each panel.

g. Provide a data sheet for each control system component together with a technical product brochure or bulletin, which include:

1) The manufacturer's model number or other identifying product designation.
2) Tag and loop number.
3) System of which it is a part of.
4) Site to which it applies.
5) Input and output characteristics.
6) Requirements for electric power.
7) Device ambient operating requirements.
8) Materials of construction.

E. Shop Drawings:

1. General:

a. Coordinate all aspects of the work so that a complete, instrumentation, computer, and control system for the facility is supported by accurate shop and record drawings:

1) Clearly show every wire, circuit, and terminal provided under this contract on one or more submitted wiring diagrams.

b. Show all interfaces between any of the following: instruments, vendor control panels, motor control centers, motor starters, variable speed drives, control valves, flow meters, chemical feeders and other equipment related to the PCIS.

c. Generate all drawings developed for this project utilizing AutoCAD by Auto Desk Version 2014, or later:

1) Furnish on CD-ROM disks, as well as hard copies on 11x17 inch plain bond paper.

d. Organize the shop drawing submittals for inclusion in the O&MMs:

1) Furnish the initial shop drawing submittal bound in one or more standard size, 3-ring, D-ring, loose leaf, vinyl plastic, hard cover binders suitable for bookshelf storage.
2) Binder ring size: 2 inches.

e. Include the letterhead and/or title block of the firm responsible for the preparation of all shop drawings. Include the following information in the title block, as a minimum:

1) The firm's registered business name.
2) Firm's physical address, email address, and phone number.
3) Owner's name.
4) Project name and location.
5) Drawing name.
6) Revision level.
7) Personnel responsible for the content of the drawing.
8) Date.

f. The work includes modifications to existing circuits:

1) Clearly show all modifications to existing circuits.

2) In addition, show all existing unmodified wiring to clearly depict the functionality and electrical characteristics of the complete modified circuits.

g. All drawings that show a modification of an existing circuit must include the name and signature of the individual who performed the field verification work, along with a statement that the individual personally performed the field verification and that the information shown is correct.

2. Shop drawing requirements:
   a. Front, side, and, rear elevations, and top and bottom views, showing all dimensions.
   b. Locations of conduit entrances and access plates.
   c. Component layout and identification.
   d. Schematic and wiring diagrams with wire numbers and terminal identification.
   e. Connection diagrams, terminal diagrams, internal wiring diagrams, conductor size, etc.
   f. Anchoring method and leveling criteria, including manufacturer's recommendations for the seismic specified in Section 01 81 10 and wind conditions specified in Section 01 81 11.
   g. Weight.
   h. Finish.
   i. Nameplates.
   j. Temperature limitations, as applicable.
3. Loop Drawings:
   a. Submit loop drawings for every analog, discrete, and fieldbus signal and control circuit:
      1) Provide a loop drawing submittal that completely defines and documents the contents of each monitoring, alarming, interlock, and control loop on this project.
      2) This requirement applies to all signal and control circuits associated with equipment provided under Division 27, Division 26, as well as equipment provided under other sections including vendor supplied equipment packages and control panels, as specified.
   b. Show every instrument and I/O point on at least one loop diagram.
   c. Provide a complete index in the front of each bound volume. Index the loop drawings by systems or process areas.
   d. Provide drawings showing definitive diagrams for every instrumentation loop system:
      1) Show and identify each component of each loop or system using requirements and symbols from ANSI/ISA S5.4 - Instrument Loop Drawings as amended by the contract drawings, as defined by the most recent revision in ISA.
      2) Furnish a separate drawing sheet for each system or loop diagram.
   e. In addition to the ISA S5.4 requirements, show the following details:
      1) Functional name of each loop.
      2) Reference name, drawing, and loop diagram numbers for any signal continuing off the loop diagram sheet.
      3) Show all terminal numbers, regardless of the entity providing the equipment.

4) MCC panel, circuit, and breaker numbers for all power feeds to the loops and instrumentation.
5) Designation of and, if appropriate, terminal assignments associated with every manhole, pull-box, junction box, conduit and panel through which the loop circuits pass.
6) Show vendor control panel, instrument panel, conduit, junction box, equipment and PCIS terminations, termination identification, wire numbers and colors, power circuits and ground identifications.
7) If a circuit is continued on another drawing show, the name and number of the continuation drawing on the loop drawing. Provide complete references to all continuation drawings whether vendor control panels, other loop drawings, drawings provided under Division 26 or other drawings.

4. Instrument Installation Drawings:
   a. Submit instrument installation, mounting and anchoring details for all components and assemblies; including access requirements and conduit connection or entry details.
   b. Furnish for each instrument a dedicated 8½x11 inch installation detail that pertains to the specific instrument by tag number.
   c. For each detail, provide certification and the hard copies provided by the instrument manufacturer for the proposed installation is in accordance with the instrument manufacturer's recommendations and is fully warrantable.
   d. For each detail, provide, as a minimum, the following contents:
      1) Necessary sections and elevation views required to define instrument location by referencing tank, building or equipment names and numbers and geographical qualities such as north, south, east, west, basement, first floor, etc.
      2) Ambient temperature and humidity where the instrument is to be installed.
      3) Corrosive qualities of the environment where the instrument is to be installed.
      4) Hazardous rating of the environment where the instrument is to be installed.
      5) Process line pipe or tank size, service type and material.
      6) Process tap elevation and location
      7) Upstream and downstream straight pipe lengths between instrument installation, pipe fittings and valves.
      8) Routing of tubing and identification of supports.
      9) Mounting brackets, stands, anchoring devices and sun shades.
      10) Conduit entry size, number, location and delineation between power and signal.
      11) NEMA ratings of enclosures and all components.
      12) Clearances required for instrument servicing.
      13) List by itemizing all manufacturer makes, model numbers, quantities, lengths required and materials of each item required to support the implementation of the detail.

5. Control Panel Drawings:
   a. Layout Drawings:

1) Submit panel, enclosure, console, furniture and cabinet layout drawings for all items provided.
2) As a minimum, include the following information:
a) To scale front, side and plan views.
b) All dimensions.
c) Heat dissipation in electrical enclosure calculations to include surface area, heat input, enclosure temperature rise, safety margins, outdoor applications and resolutions and equipment to be used to help dissipate heat rise for each enclosure.
d) Interior and exterior arrangements.
e) Mounting information, including conduit entrance location.
f) Finish data.
g) Tag number and functional name of items mounted in/on each panel, console and cabinet.
h) Nameplate legend including text, letter size and colors.

b. Wiring and Piping Diagrams:
1) Submit panel wiring and piping diagrams for every panel that contains wiring and/or piping.
2) Include the following information:
a) Name of panel.
b) Wiring and piping sizes and types.
c) Terminal strip numbers.
d) Wire tags and labels.
e) Functional name and manufacturer's designation for items to which wiring and piping are connected.
f) Electrical control schematics in accordance with ANSI standards.

c. Installation drawings:
1) Provide site-specific installation drawings for all control equipment panels; including dimensions.
2) Provide scaled drawings and show the position of the equipment at its intended installation location.
3) Show the placement of all equipment being provided under this contract and its spatial relationship to all other equipment located in the abutting and adjoining areas.
4) Show all required access and clearances associated with the equipment with a statement of compliance to manufacturer's recommendations, NEC requirements and other applicable codes.

6. Schematic Diagrams:
a. Submit schematic diagrams for all electrical equipment in ladder diagram format.
b. Include device and field connection terminal numbers on all schematic diagrams.
c. Incorporate equipment manufacturer's shop drawing information into the schematic diagrams in order to document the entire control system.

7. Control System Diagram:
a. Submit a complete set of control system diagrams including the following information:

1) All PLCs, workstations, printers, communication devices, and communication links:
   a) Show all PLCs with their current and future I/O allocation requirements, current items and spares provided, and maximum potential I/O based on available slots.
2) All cables required for communication requirements.
3) Show each component fully annotated with conduit size and number associated with the power source.

F. Testing, Calibration, and Start-up Submittal:
1. General testing submittal requirements are specified in this section.
2. Test Procedure Submittals:
   a. Submit the proposed procedures to be followed during tests of the PCIS and its components in two parts:
      1) Preliminary Submittal: Outline of the specific proposed tests and examples of proposed forms and checklists.
      2) Detailed Submittal: After successful review of the preliminary submittal, submit the proposed detailed test procedures, forms and checklists. Include a statement of test objectives with the test procedures.
3. Provide certified and witnessed test and calibration checklists for each of the following tests:
   a. Calibration, adjustment and test details for all components and systems.
   b. Factory Acceptance Tests.
   c. Loop Validation Tests.
      1) Loop Validation Certifications:
         a) After the field device loop tests have been successfully completed for all individual instruments, all separate analog control networks, all valves, all VCPs, all motors, all local operator interface panels, all motor control centers, etc., submit a certified copy of all test forms signed by the contractor, Integrator and the owner's representative, with test data entered, together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, inspected and tested.
   d. Pre-commissioning Test.
   e. Performance Test.
4. Factory Acceptance Test:
   a. Include complete test procedures and forms to be used during the test.

G. Operation and Maintenance Manuals:
1. Furnish the Engineer with a complete preliminary set of written O&MMs eight (8) weeks before calibration, start-up and/or testing.
2. Furnish in accordance with the following additional requirements.
3. Submit preliminary sets of these manuals to the Engineer for review of format and content:
   a. Engineer will return one (1) set with comments.
   b. Revise and/or amend as required and submit the requisite number of copies to the Engineer fifteen (15) days before pre-commissioning of the systems.

4. Incorporate changes that occur during startup and submit as part of the final manuals.
5. Provide comprehensive information on all systems and components to enable operation, service, maintenance, and repair.
6. Include record documents and the approved shop drawing submittals modified for conditions encountered in the field during the work.
7. Include signed results from Calibration, Loop Validation Tests, Pre-commissioning, and Performance Testing.
8. Provide installation, connection, operating, calibration, setpoints (e.g., pressure, pump control, time delays, etc.), adjustment, test, troubleshooting, maintenance, and overhaul instructions in complete detail.
9. Provide exploded or other detailed views of all instruments, assemblies and accessory components together with complete parts lists and ordering instructions.
10. Spare Parts List:
    a. Include a priced list of recommended spare parts for all the equipment furnished under this contract. Include recommended quantities sufficient to maintain the furnished system for a period of five (5) years.
    b. Annotate the list to indicate which items, if any, and quantities are furnished as part of this contract.
    c. Provide the name, address, and phone number of manufacturer and manufacturer's local service representative of these parts.
11. Organize the O&MMs for each process in the following manner:
    a. Section A - Process and Instrumentation Diagrams.
    b. Section B- Loop Drawings.
    c. Section C- Instrument Data Sheets and Brochures.
    d. Section D- Sizing Calculations.
    e. Section E- Instrumentation Installation Details.
    f. Section F- Test Results.
    g. Section G- Operational Manual.
    h. Section H- Spare Parts List.
12. Training Submittals:
    a. Develop and submit for review a General Training Plan. Include complete descriptions of all planned training classes, a preliminary training schedule, a list of all proposed instructors along with resumes, examples of proposed training manuals and a description of any special training tools to be used (simulators, self-paced modules, personal computer-based training, etc.).
    b. The Engineer will review the General Training Plan. Special emphasis will be placed on review of the qualifications of the proposed instructors and the timing of the individual courses to maximize their effectiveness. If, in the opinion of the Engineer, the proposed instructor(s) are not sufficiently qualified to conduct the specified training courses or lack experience on the specific configuration of the system, additional training must be provided by more qualified instructors.
    c. Training Course Plan submittals:
        1) For each training course or other training activity, submit a detailed, complete outline and agenda for each lesson.
        2) Describe any student pre-requisites for the course or training activity.
        3) Provide an updated schedule for all sessions of the course; including dates, times, durations and locations.
        4) Submit training materials.

d. Incorporate all submittal review comments into the course.
e. Do not conduct training courses before review and acceptance of the Course Plan submittal for the course.

H. Record Documents:
1. Provide record documents of all instrumentation drawings.
2. Record Drawing requirements:
a. Update record drawings regularly throughout the project (monthly as a minimum).
b. Record drawings must be fully updated as a condition of the monthly progress payments.
c. Submit final fully updated record drawings upon completion of the work for final review.
d. Clearly and neatly show all changes in accordance with all existing pipe, conduit, wire, instruments or other structures encountered or uncovered during construction.
3. Shop Drawings:
a. Upon completion of the work, update all shop drawings to indicate the final as-built configuration of the systems:
1) Should an error be found in a shop drawing during installation or startup of equipment, note the correction, including any field changes found necessary on the drawing and submit the corrections in the record documents.
2) Update, check, and revise all wiring drawings and other submitted drawings and documents to show final installed conditions.
b. Provide "As-Built" shop drawings for all instrumentation equipment on 11x17 inch using bond paper.
c. Provide electronic copies of these documents on CD-ROM disks in AutoCad Version 2014, or later, by Autodesk. Size all drawings to be readable and legible on 11x17 inch media.
4. Submittal Documents:
a. Provide an interim submittal of record documents after the PCIS system pre-commissioning but before performance testing.
b. Submit final record documents before substantial completion or earlier if so specified.
5. Review and Corrections:
a. Correct any record documents or other documents found to be incomplete, not accurate, of poor quality or containing errors.
b. Promptly correct and re-submit record documents returned for correction.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Perform all instrumentation and control work, whether needed for the power, control system, process, HVAC, telephone, security, etc. in accordance with all codes and standards.

B. Unless otherwise specified, each individual instrument shall have a minimum accuracy of ±0.5 percent of full scale and a maximum repeatability of ±0.25 percent of full scale.

C. Conduct Factory Acceptance Tests in accordance with paragraph 2.09 of this section.

D. Installation supervision in accordance with paragraph 3.04 of this section.
   1. Calibration: The Contractor shall furnish the services of trained technicians to perform a complete calibration of each instrument and device, as specified in this specification.

1.6 DELIVERY, STORAGE, AND PROTECTION

A. Store all equipment and materials delivered to the job site in a location that will not interfere with the construction or the owner's operations.

B. Shipping Precautions:
   1. After completion of shop assembly, successful factory acceptance test, pack all equipment, cabinets, panels, and consoles in protective crates and enclose in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust and moisture.
   2. Place dehumidifiers, when required, inside the polyethylene coverings.
   3. Skid-mount the equipment for final transport.
   4. Provide lifting rings for moving without removing protective covering.
   5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing and handling at the job site.

C. Special Instructions:
   1. Securely attach special instructions for proper field handling, storage and installation to each piece of equipment before packaging and shipment.

D. Tagging:
   1. Tag each component and/or instrument to identify its location, instrument tag number and function in the system.
   2. Firmly attach a permanent tag, indelibly machine marked with the instrument tag number as given in the tabulation, on each piece of equipment constituting the PCIS.
   3. Tag instruments immediately upon receipt in the field.
   4. Prominently display identification on the outside of the package.
   5. Utilize the tag and loop number identifications shown of the P&IDs.

E. Delivery and Inspection:
   1. Deliver products in undamaged condition, in manufacturer's original container or packaging with identifying labels intact and legible. Include date of manufacture on label.
   2. Unload products in accordance with manufacturer's instructions for unloading or as specified. Record the receipt of products at the site. Inspect for completeness and evidence of damage during shipment.
   3. Remove damaged products from the site and expedite delivery of identical new undamaged products, augment incomplete shipments or replace lost products in order not to delay the progress of the work.

F. Storage and Protection:

1. Provide for the safe storage and delivery of materials; whether furnished by the contractor or by others.
2. Meet all storage requirements of the manufacturer and provide for the safe storage of all materials and equipment as recommended by the manufacturer.
3. Store all equipment in dry permanent shelters:
    a. Provide adequate protection for stored equipment against mechanical injury.
    b. Provide space conditioning to meet the manufacturer's recommendations.
4. Protect instrumentation and control work at all times from damage, defacement or deterioration from any cause whatever.

1.7 PROJECT OR SITE CONDITIONS

A. Site Conditions:
1. Provide a PCIS, including all equipment, raceways and any other components required for a complete installation that meets the environmental conditions for the site as specified in the general requirements and below.
2. Area Classifications:
    a. Furnish enclosures that match the area classifications.
3. Site Security:
    a. Abide by all security and safety rules concerning the work on the site, as specified in Section 01 35 53.

1.8 SEQUENCING

A. General:
1. General scheduling requirements are specified in Section 01 14 40 – Construction and Schedule Constraints.
2. Refer to Section 01 11 00 for summary of work.
3. Testing requirements are specified in Section 01 91 14.
4. Work restrictions and other scheduling requirements are specified in Section 01 14 40.

B. Pre-submittal Conferences:
1. Before producing any submittals, schedule a pre-submittal conference for the purposes of reviewing the entire project, equipment, control philosophy, schedules and submittal requirements.
2. The contractor, electrical subcontractor and all manufacturer's representatives furnishing major pieces of equipment must attend, including but not limited to:
    a. Vendor Control Panels
    b. Chemical Feed Systems.
    c. Variable Frequency Drives.
    d. Lighting.
    e. Engine Generators.

C. Factory Acceptance Test (FAT):
1. Before the delivery and installation of the PCIS system at the job site, but after the procurement, assembly, and configuration of all components, perform the FAT.
2. Schedule the FAT after receiving approval of the FAT procedures submittal.

3. Submit a copy of the test procedures including all forms at least twenty-one (21) days before any scheduled test date.
4. Notify the Engineer of scheduled tests a minimum of fifteen (15) days before the date of the test.

D. Loop Validation Test:
1. Notify the Engineer of scheduled tests a minimum of thirty (30) days before the estimated completion date of installation and wiring of the PCIS.
2. Complete testing a minimum of five (5) days before the pre-commissioning phase of the project.

E. Training:
1. Complete all training before the pre-commissioning phase of the project may start.
2. Schedule the training sessions a minimum of fifteen (15) days prior to the start date of the courses.
3. Submit training manuals to the Engineer a minimum of ten (10) days before starting the training session.
4. Within ten (10) days after the completion of each session, submit the following:
   a. A list of all owner personnel that attended the session.
   b. A copy of the training materials utilized during the lesson with all notes, diagrams and comments.

F. Pre-Commissioning Test:
1. Commence after acceptance of all training, wire test, calibration tests, and loop validation tests and all inspections have demonstrated that the PCIS complies with all Contract requirements.
2. Acceptance of the PCIS pre-commissioning testing must be provided in writing by the Engineer before the performance testing may begin.

G. Provide all special tools and spare parts, refer to Paragraph 1.15 of this Section, before performance testing commences, suitably wrapped and identified.

H. Performance Testing:
1. Complete Pre-commissioning test a minimum of five (5) days before the Performance Test.
2. Conduct a 14-day Performance Test.

I. Substantial Completion: The following conditions shall be fulfilled before the PCIS is considered complete:
1. All submittals have been completed and approved.
2. The PCIS has been calibrated, loop tested and pre-commissioned.
3. The owner training has been performed.
4. All required spare parts, expendable supplies and test equipment have been delivered to the owner.
5. The performance test has been successfully completed.
6. All debris associated with installation of instrumentation has been removed.
7. All probes, elements, sample lines, transmitters, tubing and enclosures have been cleaned and are in like-new condition.

1.9 WARRANTY

A. Warrant the PCIS in accordance with the General Conditions:
   1. Provide additional warranty as specified in the individual specifications.

1.10 SYSTEM STARTUP

A. Replace or modify equipment, software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the Engineer.

1.11 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. As called out on Drawings and specified in individual instrument and equipment specifications in other sections of Division 40.

2.2 MATERIALS

A. Furnish all materials under this contract that are new, free from defects and standard products produced by manufacturers regularly engaged in the production of these devices and that bear all approvals and labels as required by the specifications.

B. Provide materials complying with the applicable industrial standards in accordance with the General Conditions.

2.3 COMPONENTS

A. Furnish all meters, instruments, and other components that are the most recent field proven models marketed by their manufacturers at the time of submittal of the shop drawings; unless otherwise specified to match existing equipment.

B. Unless otherwise specified, furnish individual instruments that have a minimum accuracy of ±0.5 percent of full scale and a minimum repeatability of ±0.25 percent of full scale.

C. Signal Transmission:
   1. Analog Signals:
      a. Furnish analog measurements and control signals that vary in direct linear proportion to the measured variable; unless otherwise indicated.

b. Furnish electrical analog signals outside control panels that are 4-20mA /24VDC; except as indicated.
c. Analog signals within enclosures may be 1-5VDC.
d. Electrically or optically isolate all analog signals from other signals.
e. All pneumatic signals shall be controlled by a 3-15psig span.
f. Discrete input signal: as indicated in the controller hardware specification.
g. Discrete output signals:
    1) Dry contacts or TRIAC outputs (with express written approval by the Engineer) as needed to coordinate with the field device.
    2) Interposing Relays:
        a) Provide interposing relays for all discrete outputs connected to the PLC; unless relay output PLC cards are provided as part of the PLC system.
h. Furnish regulated analog signals that are not affected by changes in supply voltage or load resistance within the unit's rating.
i. Maintain the total loop impedance of 10% below the published total loop impedance for 4-20mA signals at the rated value for the regulating device at the loop operating voltage.
j. Where necessary, reduce loop impedance by providing current-to-current (I/I) isolation amplifiers for signal re-transmission.

D. Discrete Circuit Configuration:
1. Configure discrete control circuits to fail safe, on loss of continuity or loss of power.
2. Alarm contacts: Fail to the alarm condition.
3. Control contacts fail to the inoperative condition unless otherwise indicated on the drawings.

E. Grounding:
1. Provide control panels with a signal ground bus isolated from the power ground bus:
    a. Provide multiple panels in one location with a common point for signal ground bus connection to ground.
2. Single-point ground shields and measurement loops at the source panel external terminals, unless otherwise noted, by bonding to the control panel signal ground bus.
3. Provide isolating amplifiers within control panels for field equipment possessing a grounded input or output; except when the panel circuit is galvanically isolated.

2.4 ACCESSORIES

A. Provide flow conditioning devices or other required accessories if necessary to meet the accuracy requirements in the contract documents.

2.5 SOURCE QUALITY CONTROL

A. Provide all equipment that is new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products that bear all approvals and labels as required by the specifications.

B. Arrange with all manufacturers of the equipment and fabricators of panels and cabinets, to allow the owner and Engineer to inspect and witness the testing of the equipment at the site of fabrication:
   1. Equipment includes the cabinets, special control systems, flow measuring devices and other pertinent systems and devices.

C. Factory Testing is specified in Section 01 91 14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Review the existing site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.

B. Provide a complete instrumentation and control system:
   1. Install all extra conduits, cables and interfaces as may be necessary to provide a complete and operating electrical and process control and instrumentation system.

3.2 INSTALLATION

A. The construction and installation of all instrumentation, control equipment and materials must comply with all applicable provisions of:
   1. Section 01 40 10 – Quality Assurance, Quality Control.
   2. National Electrical Code.
   3. Applicable local codes and regulations.

B. Equipment locations shown on the drawings may change due to variations in equipment size or minor changes made by others during construction:
   1. Verify all dimensions as indicated on the drawings. Actual field conditions govern all final installed locations, distances and levels.
   2. Review all information shown on the drawings, including architectural, structural, mechanical, instrumentation and electrical to coordinate work as necessary to adjust to all conditions that arise due to such changes.
   3. Make minor changes in location of equipment before rough-in; upon approval and as directed by the owner and/or Engineer.

C. Perform all related electrical work in accordance with the applicable Sections of Division 26.

D. The PCIS configurations are diagrammatic:
   1. The locations of equipment are approximate unless dimensioned.
   2. Where project conditions require, make reasonable changes in locations and arrangements; upon approval by owner and/or Engineer.

E. Field Instruments Installation:
   1. Install field instruments in accordance with the contract documents, ANSI/API 550 and 551 and the manufacturer's instructions.

2. Mount field instruments so that they can be easily read, readily approached, and easily serviced, and so they do not restrict access to mechanical equipment:
    a. Mount field instruments on a pipe stand or local panel, if they are not directly mounted, unless otherwise indicated on the drawings.
    b. Provide sun shields for all field electronic instruments exposed to direct sunlight.
3. Make connections from rigid conduit systems to field instruments with PVC coated flexible conduit:
    a. Type of flexible conduit required for the area classification. Refer to Section 26 00 00 for area classification.
    b. Maximum length of 24 inches or to meet local code.
4. Connect field instruments with cable as specified in Division 26, except when the manufacturer requires the use of special cable, or otherwise specified herein. Special cable applications shall be in accordance with the NEC.
5. Verify the correctness of each installation:
    a. Polarity of electric power and signal connections.
    b. Ensure all process connections are free of leaks.

F. Process Sensing Lines and Air Tubing:
1. Install individual tubes parallel and/or perpendicular to and near the surfaces from which they are supported.
2. Provide supports for rigid tubing at intervals of not more than 3 feet.
3. Slope horizontal runs of instrument tubing at a minimum of 1/16th-inch per foot to allow for draining of any condensate.
4. Bends:
    a. Use proper tool.
    b. Make bends for parallel lines symmetrical.
    c. Make bends without deforming or thinning the walls of the tubing.
5. Square-cut and clean all ends of tubing before being inserted in the fittings.
6. Provide bulkhead fittings at all panels requiring pipe and/or tubing entries.
7. Use stainless steel tubing for all piping that is hard piped from the air header, unless otherwise noted on the drawings or not compatible with the fluids or atmosphere in the area.
8. Use flexible connections only on moving equipment and under the constraint that the length shall be less than 1.5 times to maximum travel of the equipment.

G. Conduit, Cables, and Field Wiring:
1. Provide all PCIS equipment cables and process LAN communication networks under Division 40.
2. Provide terminations and wire identification as specified in Division 26.
3. Protect all wiring from sharp edges and corners.
4. Provide all conduits, fittings, boxes, etc. in accordance with all the requirements of Division 26.

H. Equipment Tie-Downs:
1. Anchor all instruments, control panels and equipment by methods that comply with seismic and wind bracing requirements which apply to the site.
2. All control panels, VCPs, LCPs, RTUs, PCM's, etc., shall be permanently mounted and tied down to structures.

I. Existing Instrumentation:
   1. Clean, recondition and re-calibrate each existing instrument to be reused, removed or reinstalled using an authorized service facility of the instrument manufacturer.
   2. Provide certification of this work before reinstallation of each instrument.

J. Instrument Tagging:
   1. See Drawings.
   2. Provide all field-mounted instruments with nameplates:
      a. Nameplates engraved with the instrument's full tag number as indicated on the drawings. Affix tags with stainless steel wire fasteners.
   3. Provide all back of panel instruments with nameplates engraved with the instrument's full tag number as indicated on the drawings.
   4. Provide all front of panel instruments with a nameplate:
      a. Engravings to include the instrument's full tag number and service description.
      b. Secure nameplates to the panel with stainless steel screws.
      c. Use an approved adhesive if screws would violate the NEMA or other ratings of the enclosure.

K. Cable and Conductor Termination:
   1. Terminate all cables and conductors on terminal blocks.
   2. Provide terminal block enclosures, where required, suitable for the area classification as specified in Division 26.

L. Surge Protection:
   1. Provide outdoor field instrument loops with voltage surge protection units at instruments.
   2. Individually fuse each 4-20mA DC loops with a 1/16 ampere slow blow fuse between power supplies and receiver surge protectors.
   3. Provide voltage surge protection for 4-wire transmitters and analyzers, protecting both power source and signal loop.

M. FIELD QUALITY CONTROL

N. Inspection:
   1. Allow for inspection of PCIS installation in accordance with Section 01 40 10.
   2. Provide any assistance necessary to support inspection activities.
   3. Engineer inspections may include, but are not limited to, the following:
      a. Inspect equipment and materials for physical damage.
      b. Inspect installation for compliance with drawings and specifications.
      c. Inspect installation for obstructions and adequate clearances around equipment.
      d. Inspect equipment installation for proper leveling, alignment, anchorage and assembly.
      e. Inspect equipment nameplate data to verify compliance with design requirements.
      f. Inspect cable terminations.
   4. Inspection activities conducted during construction do not satisfy inspection requirements outlined in Section 01 91 14.

O. Field Testing is specified in Section 01 91 14.

P. Installation Supervision:
1. Ensure that the entire PCIS is installed in a proper and satisfactory manner. At a minimum provide the following services:
a. Installation Resources:
1) Coordinate with the contractor regarding installation requirements of the contract documents.
2) Provide technical assistance to installation personnel by telephone or face-to-face.
3) Furnish installation personnel with at least one copy of the approved submittals.
4) Provide the instrument installation details specified in Article 1.05 - Submittals.
5) Provide periodic inspections during the construction period.
6) Provide a complete check of the completed installation to ensure that it is in conformance with the requirements of the equipment manufacturer and the contract documents.
7) Field verify accuracy and calibration of all instruments.

3.3 ADJUSTING

A. Control Valves:
1. Stroke all control valves, cylinders, drives and connecting linkages from the OIT and/or HMI, as well as local control devices. Adjust to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions and remote feedback of valve status and position indication.
2. Check control valve actions and positioner settings with the valves in place to ensure that no changes have occurred since the bench calibration.

B. Make all revisions necessary to the control system software, as directed by the Engineer. It is understood that the contractor knows and agrees that changes will be required in the control system software during the Factory Acceptance Tests, the Pre-Commissioning, Performance Testing, Start-up and during the warranty period.

3.4 CLEANING

A. Vacuum clean all control panels and enclosures before start-up and again after final completion of the project.

B. Clean all panel surfaces.

C. Return to new condition any scratches and/or defects received during installation.

D. Wipe all instrument faces and enclosures clean.

E. Leave wiring in panels, manholes, boxes and other locations in a neat, clean and organized manner:
1. Neatly coil and label all spare wiring lengths with to-from indications for each set.

2. Shorten, re-terminate and re-label excessive spare wire and cable lengths, as determined by the Engineer.

F. As specified in other sections of the contract documents.

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SECTION 40 63 43
PLC-BASED CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. PLC-based control systems shall be supplied by the Contractor, Integrator, AWC, and Vendors as specified in 40 61 00 and the Contract Documents. Installation shall be by the Contractor. All requirements for supply shall be in accordance with this Section and all suppliers are referred to as the Contractor for the purpose of supply.

B. The Contractor shall furnish, supervise installation, assemble, configure and place into service the PLC-based control system.

C. The Contractor shall be responsible for selecting, configuring, and verifying correct operation of compatible hardware and software to provide a complete and functional control system. The PLC-based control system hardware and software being furnished under this Contract shall be a standardized system which utilizes off-the-shelve commercially available configurations of hardware and software modules.

D. Provide a complete and operational system, fully programmed to meet all the requirements of the Proposal Documents. The following work, equipment and services shall be included in this Contract but not be limited to:
   1. Prepare and submit for approval complete control system hardware and software shop drawings.
   2. Furnish complete and operational control systems, including all peripherals and other equipment specified herein.
   3. Perform all control system tests, adjustments, and calibrations.
   4. Furnish qualified labor to perform start-up services.
   5. Furnish qualified instructors to provide complete control system instruction and training.
   6. Furnish all required control system tools, test equipment, spare parts, supplies, technical manuals, reproducible “As-Built” drawings, and program listings as specified herein.

E. All PLCs provided for the control system shall exhibit 100 percent interchangeability of parts.

F. The Proposal Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its sub-contractors to review all sections to insure a complete and coordinated project. In particular, the following sections should be used in conjunction with this section:
   1. Section 40 61 00 – Process Control and Instrumentation Systems General
   2. Section 40 78 00 – Control Panel Instruments

1.2 REFERENCES

A. All PLC-based control systems provided under this contract shall comply with all of the commercial standards and codes in accordance with Section 40 61 00 – Process Control and instrumentation Systems General.

1.3 DEFINITIONS

A. Definitions used in this section are in accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

1.4 SUBMITTALS

A. Shop drawing submittals shall be provided in accordance with Section 40 61 00 – Process Control and Instrumentation Systems General and Section 01 33 20 – Submittal Procedures.

1.5 QUALITY ASSURANCE

A. All work shall be performed in accordance with quality assurance and warranty requirements specified in Section 40 61 00 – Process Control and Instrumentation Systems General.

1.6 DELIVERY, STORAGE, AND PROTECTION

A. All equipment and materials delivered to the job site shall be stored in a location which will not interfere with the operations of the Owner's personnel or interfere with construction.

B. Storage and handling will be performed in manners which will afford maximum protection to the equipment and materials.

C. It is the Contractor's responsibility to assure proper handling and on-site storage.

D. Unless otherwise specified, all PLC-based control systems hardware shall be delivered to the project site and stored in accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

1.7 PROJECT / SITE CONDITIONS

A. The project site conditions are defined in Section 40 61 00 – Process Control and Instrumentation Systems General.

1.8 SEQUENCING AND SCHEDULING

A. Unless otherwise specified, work outlined in this section shall be schedule and sequenced as specified in Section 40 61 00 – Process Control and Instrumentation Systems General.

B. Training shall be conducted in accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

1. The training as required by paragraph 3.4 of this Section shall be scheduled concurrent with the calibration, equipment testing, and process system testing phases of the project.

1.9 MAINTENANCE

A. Maintenance shall be provided in accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials and all PLC equipment furnished under this Contract shall be new, free from defects, of first quality, off-the-shelf and produced by manufacturers regularly engaged in the manufacture of these products. No proprietary hardware or software may be used.

B. Hardware Commonality: Where there is more than one item of similar equipment being furnished all such similar equipment shall be the product of a singular manufacturer.

C. All CPEs, I/O modules, power supplies and other accessories required to form a complete system shall be as shown on the drawings but are the responsibility of the Contractor to furnish in order to provide a complete, operable system.

2.2 EQUIPMENT

A. Provide major equipment as follows:
1. As shown on attached table following this Section, listed as 40 63 43a PLC-Based Control System List.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The contractor shall utilize personnel to accomplish or supervise the physical installation of all elements, components, accessories or assemblies which it furnishes.

B. After installation of the entire control is completed, the installation shall be inspected jointly by the supplier, contractor, owner and/or Engineer.
1. Any problems shall be corrected immediately. When all parties are satisfied with the installation, a written certification of the installation shall be delivered to the Engineer.
2. The certification shall state that all PLC communications and I/O modules, modems, system grounds, LAN, communication network, workstations, printers and all other components of the control system have been inspected and are installed in accordance with the manufacturer's guidelines.

C. Unless otherwise specified, the ICSC shall provide field inspection services in accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

3.2 FIELD QUALITY CONTROL

A. Testing of all analog inputs and outputs of the control system shall have their calibration checked at a minimum of five points (0%, 25%, 50%, 75% and 100%) to verify consistency with the balance of the analog loop.
   1. This calibration check shall be done in conjunction with the analog loop tests specified in Section 40 61 00.
   2. Workstations displays and PLC tag name registers shall both be verified for correctness.

B. After the control system installation has been certified and the analog points have been calibrated, the entire Process Control System shall be tested to verify that all discrete inputs and outputs of all PLCs and any workstations are correct.
   1. As much as possible, points shall be checked "end-to-end". For example, valve status inputs shall be checked by stroking the valve and a pump start output shall be checked by using it to start the pump.
   2. Simulated testing shall be allowed only when no practical alternative exists.
   3. Workstation displays shall be verified for correctness at the same time.
   4. An I/O checklist developed by the ICSC shall be used to record test results and a copy provided to the Engineer upon completion.
   5. The ICSC shall submit to the Engineer a system testing completion report demonstrating Process Control System conforms to requirements of this section.

C. SCADA System Testing: After all system and subsystem installations have been certified and analog loop calibration and discrete I/O testing have been completed, the SCADA system testing shall be performed by the installation contractor.
   1. SCADA system testing shall operate the various process systems of the facility to verify compliance with all functional requirements specified; including the automatic control modes and control system interlocks.
   2. Tests which fail to demonstrate the required operation shall be repeated in their entirety or continued after corrective action has been completed at the discretion of the owner and/or Engineer.
   3. During SCADA system tests, the ICSC shall have a representative on-site continuously who is capable of trouble-shooting and modifying the Process Control System configuration programming.

D. Plant Pre-commissioning Start-up Test: The ICSC shall provide start-up support to include the installation contractor's personnel, electrical personnel, chemical feed system personnel and the PLC and SCADA software system manufacturer's representative as required during the testing period to produce a fully-operational facility.
   1. This support shall be provided at no additional cost to the owner.
   2. Pre-commissioning and start-up test shall be conducted in accordance with the requirements of Section 40 61 00.

E. Final Acceptance Test: During this test, the entire SCADA control system shall be continuously operated and maintained, 7 days per week, 24 hours per day, during the test period, with zero

downtime resulting from system failures. If a system failure occurs, the test shall be considered a failure and not acceptable and the installation contractor shall be required to repeat the test from the beginning. The entire control system shall be acceptable only after all equipment and software has satisfied the performance test requirements. At no additional cost to the owner, the ICSC shall be responsible for any downtime or project delays resulting from system failures related to the Process Control System. Downtime resulting from the following shall be considered system failures:

1. If a component failure cannot be repaired/replaced within 4 hours.
2. Downtime of any component, exclusive of I/O, whose failure results in the inability of the operator to monitor and manipulate control loops from the associated workstations using standard workstation interface procedures.
3. Downtime resulting from concurrent failure of any CRT, keyboard, or mouse which is associated with the workstation.
4. Downtime in excess of 2 hours resulting from any I/O component failure.
5. Downtime resulting from concurrent failure of 2 or more I/O components in a single PLC.
6. Downtime of any component/peripheral associated with the controls network if the failed component results in a disabling of the historical functions or the failed component is not repaired or replaces within 8 hours.

3.3 DOCUMENTATION SCHEDULE

A. When the installation of the Process Control System is complete, a written certification of the installation shall be delivered to the Engineer. The certification shall state that all PLC communication and I/O modules, modems, system grounds, LAN, communication network, workstations, printers and all other components of the control system have been inspected and are installed in accordance with the manufacturer's and PCIS guidelines contained in all sections of Section 40 in these specifications.

1. The contractor, through its ICSC, shall submit to the Engineer a system testing completion report when each process system and all aspects of the configuration software have been successfully tested as described herein.
    a. The report shall note any problems encountered and what action was required to correct them.
    b. It shall include a clear and unequivocal statement that the process systems have been thoroughly tested and are complete and functional in accordance with all specification requirements.
2. The ICSC through the installation contractor shall submit a final acceptance test completion report which shall state that all contract requirements have been met and which shall include:
    a. A listing of all PLC system equipment maintenance/repair and modification activities conducted during testing.
    b. A listing of all components which were unable to operate successfully and how they were replaced/repaired.
3. Operator & Maintenance Training: Furnish a completion report which shall include a list of all owner personnel that attended the class, an evaluation of owner personnel that attended the class via written testing or equivalent evaluation and a copy of the hard copy text utilized during the class with all notes, diagrams and comments.

3.4 TRAINING

A. In addition to the training identified in Section 40 61 00 – Process Instruments and Controls General, the ICSC shall provide training for the purpose of familiarizing the owner's maintenance and operating personnel with the use, maintenance, calibration and repair of all components of the control system.

END OF SECTION

40 630 43a			
PLC-Based Control Systems List			
Equipment	**Manufacturer**	**Model No.**	**Description (See notes at bottom of document)**
PLC Enclosure	Hoffman	A726024FSD	Two-door, floor-mount, type 12, 72"x60"x24"
Enclosure Backplane	Hoffman	A72P60F1	Sub panel
Enclosure Light	Hoffman	LED24V15	LED light
Folding Shelf	Hoffman	A-CSHELF18	Folding shelf
Accessories	Varies	Varies	Provide with thermostat, 8" cooling fan, and filters
PLC	Allen Bradley	1756-L-81E	ControlLogix 5580 with embedded Ethernet/IP port.
PLC Power Supply	Allen Bradley	1756-XXXX	Chassis mounted power supply as required for final configuration.
PLC Digital Input Modules	Allen Bradley	1756-IA16	ControlLogix 120VAC 16 point digital input modules.
PLC Digital Output Modules	Allen Bradley	1756-OA16	ControlLogix 120VAC 16 point digital output modules.
PLC Analog Input Modules	Allen Bradley	1756-IF16	ControlLogix 16 point analog input modules.
PLC Analog Output Modules	Allen Bradley	1756-OF8	ControlLogix 8 point analog output modules.
Chassis	Allen Bradley	1756-XXXX	Standard ControlLogix chassis as required for final configuration.
Managed Network Switch	Allen Bradley	1783-BMS20CGN	Stratix 5700 with 20 ports, 16 faster ethernet, 2 gigbit ethernet, and 2 MM fiber ports.
Unmanaged Network Switch	Allen Bradley	1783-US16TB	Stratix 2000 with 16 fast ethernet ports
Power Supplies	Phoenix Quint	QUINT-4PS	QUINT 120VAC to 24VDC DIN rail mounted power supply.
UPS	Liebert	GXT4	Size as required for load, minimum of 1500VA
UPS Bypass	Liebert	MP-120C	MicroPOD maintenance bypass

Notes: No Substitutions allowed, except for items listed or equal.

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SECTION 40 63 44
PC-BASED SCADA SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. PC-based SCADA systems hardware.

B. Related Sections:
   1. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-contractors to review all section s to insure a complete and coordinated project.
   2. In particular the following sections should be used in conjunction with this section:
      a. Section 40 61 00 – Process Control and Instrumentation Systems General.

1.2 REFERENCES

A. In accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

1.3 DEFINITIONS

A. In accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

1.4 SYSTEM DESCRIPTION

A. General:
   1. The Integrator shall furnish all hardware, software, and non-HMI programming for the PC-based SCADA system.
   2. The Contractor shall furnish, supervise installation, assemble, configure, and place into service the PC-based SCADA.
   3. The Programming In accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

B. Scope of Work:
   1. The Contractor shall provide all installation, all labor and supervision and all engineering required to assure the proper installation and operation of the complete control system.
   2. Provide and install a complete and operational systems and fully programmed to meet all the requirements of the Contract Documents. The following work, equipment and services shall be included in this Contract but not be limited to:
      a. Prepare and submit for approval complete control system hardware and software shop drawings.
      b. Furnish and install complete and operational control systems, including all peripherals and other equipment specified herein.
      c. Perform all control system tests, adjustments, and calibrations.
      d. Furnish qualified labor to perform the complete control system installation and start-up.

e. Furnish qualified instructors to provide complete control system instruction and training.
f. Furnish all required control system tools, test equipment, spare parts, supplies, technical manuals, reproducible "As-Built" drawings, and program listings as specified herein.

3. The Contractor shall be responsible for selecting, configuring, and verifying correct operation of compatible hardware and software to provide a complete and functional control system.
4. The control system shall consist of the systems as depicted on the Control System block Diagram.

C. General System Requirements:
1. The control system shall be in conformance with the following key system criteria:
a. All PLCs/PACs provided for the control system shall exhibit 100 percent interchangeability of parts.
b. All process communication protocols consist with control system block diagram.

1.5 SUBMITTALS

A. In accordance with Section 40 61 00 – Process Control and Instrumentation Systems General."

1.6 QUALITY ASSURANCE

A. General Requirements:
1. In accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. All equipment and materials delivered to the job site shall be stored in a location which will not interfere with the operations of the Owner's personnel or interfere with construction.

B. Storage and handling will be performed in manners which will afford maximum protection to the equipment and materials.

C. It is the System Supplier's responsibility to assure proper handling and on-site storage.

D. In accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

1.8 PROJECT / SITE CONDITIONS

A. In accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

1.9 SEQUENCING AND SCHEDULING

A. In accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

B. The System Supplier's attention is directed to the construction sequencing requirements contained within the Contract Documents.

C. The System Supplier through its ICSC shall provide on-loan, any and all control system equipment required for partial start-up of a process area or system.

D. Training.
   1. In accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.
   2. The training as required by paragraph 3.7 of this Section shall be scheduled concurrent with the calibration, equipment testing, and process system testing phases of the project.

1.10 WARRANTY

A. In accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

1.11 MAINTENANCE

A. In accordance with Section 40 61 00 – Process Control and Instrumentation Systems General.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials and all PLC equipment furnished under this Contract shall be new, free from defects, of first quality, off-the-shelf and produced by manufacturers regularly engaged in the manufacture of these products. No proprietary hardware or software may be used.

B. Hardware Commonality: Where there is more than one item of similar equipment being furnished all such similar equipment shall be the product of a singular manufacturer.

C. All PCs, monitors, power supplies and other accessories required to form a complete system shall be as shown on the drawings but are the responsibility of the Contractor to furnish in order to provide a complete, operable system.

2.2 EQUIPMENT

A. Provide major equipment as follows:
   1. As shown on attached table following this Section, listed as 40 63 44a PC-Based SCADA System List.

PART 3 - EXECUTION

3.1 EXAMINATION

A. In accordance with Section 40 61 00.

3.2 INSTALLATION

A. The ICSC shall utilize personnel to accomplish, or supervise the physical installation of all elements, components, accessories, or assemblies which it furnishes.
   1. The ICSC shall employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies it furnishes.

B. All components of the SCADA system including all LAN cables shall be the installation responsibility of ICSC unless specifically noted otherwise.
   1. Grounding shall be shown on submittal drawings.
   2. After installation of the SCADA system is completed, the installation shall be inspected jointly by the ICSC.

3.3 FIELD QUALITY CONTROL

A. Testing:
   1. Workstations displays and PLC programs shall both be verified for correctness.

B. Acceptance Test.
   1. In accordance with Section 40 61 00.
   2. During the test, the entire SCADA system shall be continuously operated and maintained, 7 days per week, 24 hours per day, during the test period with zero downtime resulting from system failures.
      a. If a system failure occurs, the test shall be considered a failure and not acceptable.
      b. The ICSC shall repeat the test.
      c. The entire control system shall be acceptable only after all equipment and software has satisfied the performance test requirements.
   3. Downtime resulting from the following shall be considered system failures:
      a. If a component failure cannot be repaired/replaced within 2 hours.
      b. Downtime of any component, exclusive of I/O, whose failure results in the inability of the Operator to monitor and manipulate control loops from the associated workstations using standard workstation interface procedures.
      c. Downtime resulting from concurrent failure of any CRT, keyboard, or mouse which is associated with the workstation.
      d. Downtime in excess of 2 hours resulting from any I/O component failure.
      e. Downtime resulting from concurrent failure of 2 or more I/O components in a single PLC.
      f. Downtime of any component/peripheral associated with the LAN if the failed component:
         1) Results in a disabling of the historical functions.
         2) The failed component is not repaired or replaces within 8 hours.
   4. The ICSC through the Contractor shall submit a final acceptance test completion report in accordance with paragraph 3.9 of this Section.
   5. Final acceptance, in writing, of the entire control system shall be provided by the Engineer if the results of all of the performance tests are acceptable.

C. In accordance with Section 40 61 00.

3.4 CLEANING

A. In accordance with Section 40 61 00.

3.5 DEMONSTRATION

A. In accordance with Section 40 61 00.

3.6 SCHEDULES

A. In accordance with Section 40 61 00.

B. Documentation Schedule.
   1. When the installation is complete, a written certification of the installation shall be delivered to the Engineer.
      a. The certification shall state that all PLCs/PACs communication and I/O modules, modems, system grounds, LAN, communication network, workstations, printers, and all other components of the SCADA system have been inspected and are installed in accordance with the manufacturer's guidelines.
   2. The System Supplier through its ICSC shall submit to the Engineer a system testing completion report when each process system and all aspects of the configuration software have been successfully tested as described herein.
      a. The report shall note any problems encountered and what action was required to correct them.
      b. It shall include a clear and unequivocal statement that the process systems have been thoroughly tested and are complete and functional in accordance with all specification requirements.
   3. The ICSC through the Contractor shall submit a final acceptance test completion report which shall state that all contract requirements have been met and which shall include:
      a. A listing of all SCADA system equipment maintenance/repair activities conducted during testing.
      b. A listing of all components which were unable to operate successfully.

3.7 TRAINING

A. In addition to the training identified in Section 40 61 00 – PCIS General, the ICSC shall provide training for the purpose of familiarizing the Owner's maintenance and operating personnel with the use, maintenance, calibration, and repair of all components of the SCADA system.

B. Training shall be specifically tailored to this project and reflect the SCADA system installation and configuration.

END OF SECTION

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40 63 44a			
PC-Based SCADA Systems List			
Equipment	**Manufacturer**	**Model No.**	**Description (See notes at bottom of document)**
SCADA Server			
SCADA Client (panel mount)	Intel	NUC11TNKv7	Intel NUC 11 Pro Mini PC with Windows 10
SCADA Client (office)			
SCADA Monitors (office)			
SCADA Monitors (panel mount)	Hope Industrial	HIS-ML23-CGTC	panel mount 23" touch screen monitor
SCADA keyboard (panel mount)	Hope Industrial	KB-R3-WMT-BLK-4-USB	Panel mount keyboard
SCADA Software	Inductive Automation	Ignition	

Notes: No Substitutions allowed, except for items listed or equal.

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SECTION 40 71 13
FLOW-MAGNETIC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Instruments for instrumentation and control systems that are to be permanently installed.

B. Related Sections
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. ISA: Instrumentation Systems and Automation Society.
   4. NFPA: National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

A. Furnish all instruments as identified on the P&IDs and instrument lists shown on mechanical equipment lists.

B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.

C. Calibration of instruments shall be performed by the Instrumentation and Control Systems Contractor (ICSC).

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Section 01 33 20.

B. Product Data:
   1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
   2. Completed instrument data sheets including catalog number and source for determining catalog number.

3. Manufacturer's installation instructions.

C. Shop Drawings:
   1. Mechanical connection diagrams.
   2. Sensor transducer mounting requirements with dimensions and elevations.
   3. Electrical connection diagrams.

D. Test Reports:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.

E. Operating Manuals:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.
   2. Complete installation, calibration, and testing manuals.

F. Record Drawings:
   1. Complete field calibration sheets, including range, span, PLC/PAC I/O address, register, and scaling coefficients.

1.6 QUALITY ASSURANCE

A. Manufacturer's representative shall be responsible for proving flow meter operation and 4-20 ma loop accuracy.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated van or structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
   1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.

1.8 PROJECT/SITE CONDITIONS

A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

A. Provide a spare pipe spool for each meter size to be used in the event the meter tube must be removed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. As identified on the instrument data sheets.

B. Hardware Commonality:
1. All instruments, which utilize a common measurement principle, for example, d/p cells, pressure transmitters, level transmitters that monitor hydrostatic head, shall be furnished by a single Manufacturer.
2. All panel-mounted instruments shall have matching style and general appearance.
3. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single Manufacturer.

2.2 MANUFACTURED UNITS

A. Flow Meters:
1. Magnetic Flow Meters.
a. General:
1) Magnetic flowmeter systems shall be of the low frequency electromagnetic induction type and produce a DC-pulsed linear signal which is directly proportional to the liquid flow rate.
2) Complete zero stability shall be an inherent characteristic of the flowmeter system.
3) Each magnetic flow metering system shall include:
a) A metering tube.
b) Signal cable.
c) Transmitter.
d) Flow meter grounding rings.
b. Source quality control.
1) Shall be manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.
c. Metering tube:
1) Constructed of 316 stainless steel
2) Utilize a minimum of 2 bullet-nosed, self-cleaning electrodes.
3) Liner in conformance with:
a) As identified on the instrument data sheet.
b) Manufacturer's recommendations for the intended service.
c) Whichever is the more stringent.
4) Electrodes in conformance with:
a) As identified on the instrument data sheet.
b) Manufacturer's recommendations for the intended service.
c) Whichever is the more stringent.
5) Meter housing NEMA 4X corrosive conditions.
6) Meter coating consisting of epoxy painted finish.
7) Two grounding rings:

a) Which are in conformance with the Manufacturer's bore and material recommendation for the meter's intended service.
b) Designed to protect and shield from abrasion the liner's edge interface at the meter's end.

d. Transmitter.
1) Microprocessor-based signal converter/transmitter.
2) Utilize DC-pulse technique to drive flux-producing coils.
3) Contain a 6-digit display for flow rate, percent of span, and totalizer.
4) Operator interface consisting of keypads which respond to English text entry.
5) Integral zero return to provide a consistent zero output signal in response to an external dry contact closure.
6) Integral low flow cut-off zero return.
7) Automatic range change.
8) Programmable parameters including:
a) Meter size.
b) Full scale flow rate.
c) Magnetic field frequency.
d) Time constant.
9) Data retention for a minimum of 5 years without auxiliary main or battery power.
10) Self-diagnostics and automatic data checking.
11) Protected terminals and fuses in a separate compartment which isolates field connection from electronics.
12) Ambient operating temperature limits of -29 to 60 °C (-20 to 140 °F).

e. Performance requirements:
1) Time constant:
a) 0.5 to 1,000 seconds.
2) Accuracy:
a) 0.25 percent of flow rate from 10 to 100 percent of full scale for velocities over 3 ft per second.
3) Repeatability:
a) 0.25 percent of full scale.
4) Isolation:
a) Galvanic or.
b) Optical.
5) Power supply:
a) 120 VAC ± 10%.
b) 60 Hz.
c) 30 Watts Max.
6) Output/Input signal:
a) Output signal: Measured range – Current 0/4 to 20 mA;

f. Factory testing:
1) Each flow metering system shall be hydraulically calibrated at a facility which is traceable to the National Institute of Testing Standards.
2) The calibration procedure shall conform to the requirements of MIL-STD-45662A.

3) A real-time computer generated printout of the actual calibration data indicating apparent and actual flows at 20%, 40%, 60%, 80% and 100% of the calibrated range shall be submitted to the Engineer at least thirty (30) days prior to shipment of the meters to the project site.

g. Manufactures:
   1) Siemens Mag 5000.
   2) Or, Engineer/Owner Pre-approved Equal.

2.3 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated in facilities and with instruments traceable to the National Bureau of Standards.
   1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, flowrates, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

A. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances. Weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
   1. It is the Contractor's responsibility to install all instruments in conformance with manufacturer's recommendations.
   2. It is the Contractor's responsibility to notify the Engineer of any installation conditions that may be shown at variance with the manufacturer's recommendations

3.4 FIELD QUALITY CONTROL

A. The ICSC shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 61 00.

3.5 ADJUSTING

A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the Engineer prior to commissioning.

B. All instrument calibration shall be witnessed by the Owner's Representative.

C. Each and every instrument shall be tested during the Loop Validation Tests and the Owner's Representative shall witness the response in the PLC/PAC control system and associated registers.

3.8 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. The Contractor shall replace any instruments damaged prior to commissioning.

B. The Engineer shall be the sole party responsible for determining the corrective measures.

3.9 SCHEDULES

A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the Contractor's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review. The Contractor shall provide documented evidence for a differential plus or minus that results from these changes.

B. The Contractor shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with paragraph 1.5 of this section.
   1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

SECTION 40 71 80
ROTAMETERS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide rotameters and appurtenant work, complete and operable, in accordance with the Contract Documents.

PART 2 - PRODUCTS

2.1 GENERAL

A. All meters shall be suitable for the service and chemicals conveyed at process temperatures. Refer to materials list in Section 46 33 00 – Chemical Feeding Equipment, General for suitable materials.

B. Basic Design: Unless otherwise indicated, rotameters in chemical solution lines and where indicated shall have vertical bottom inlets and top outlets with ANSI 150-lb flanged ends, for vertical mounting. Meters in gas, air, and pump seal flushing lines shall be of the modified rotameter design with screwed ends, spring-loaded pistons, and union bodies for mounting in any position. Rotameters shall be rated for a minimum working pressure of 150 PSI.

2.2 BASIC MATERIALS

A. Flanged Meters for Chemical Solutions: Flanged rotameters for chemical solutions and other service where indicated, shall be calibrated in gallons per minute. The meters shall have 10-inch long scales (unless otherwise noted), and a range of 10:1 with an accuracy of ± 2%. Scales shall be suitable for a capacity range as indicated for the service (generally 0-10 gph for chemical, 0-10 gpm for carrier water service). The following body materials shall be used:
   1. Chlorine Service - cast iron ends, Teflon-lined, or PVC ends, with heavy borosilicate glass tubes and packing glands.
   2. Activated carbon solution - Type 316 stainless steel construction with magnetically actuated float and scale.
   3. Other chemicals - Type 316 stainless steel ends with heavy borosilicate glass tubes and packing glands, or other best suitable material. All materials including wetted parts and floats shall be suitable for designated service.

B. Screwed Meters for Water, Air, and Fuel Gas: Rotameters with NPT screwed ends for water, air, and fuel gas service shall be calibrated in gallons per minute or cubic feet per minute. The bodies shall have union ends for ease of maintenance, polysulphone tubes, aluminum or brass end fittings, Type 316 stainless steel internal parts, and scales suitable for the capacity range in the schedule above. The meters shall have an accuracy of ±5% over the capacity range.

C. Manufacturers, or Equal
   1. Chlorine Service
      a. Emerson (Brooks) No. 1180

b. US Filter/Wallace and Tiernan "Varea-Meter"
c. King Instrument Co. 7xxx Series
d. Or, Engineered Approved Equal

2. Activated Carbon
   a. Emerson (Brooks) No. 3611
   b. US Filter/Wallace and Tiernan "Varea-Meter"
   c. King Instrument Co. 7xxx Series
   d. Or, Engineered Approved Equal
3. Other Chemicals
   a. Emerson (Brooks) No. 1144
   b. US Filter/Wallace and Tiernan "Varea-Meter"
   c. King Instrument Co. 7xxx Series
   d. Or, Engineered Approved Equal
4. Water, Air and Gas Meters
   a. Headland "In-Line Meters"
   b. Universal Flow Monitors, Inc. "INSITE" meters.
   c. King Instrument Co. 7xxx Series
   d. Or, Engineered Approved Equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Rotameters shall be installed in chemical solution lines, in dilution water lines, in pump seal flushing lines, in gas and air lines, and where indicated.

B. Rotameters shall be installed in strict accordance with the manufacturer's printed instructions.

END OF SECTION

SECTION 40 72 76
LEVEL-SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Instruments for instrumentation and control systems that are to be permanently installed.
   2. Level switches and floats used for level measurement.
      a. Mechanical.
      b. Tipping Float.
      c. Reed.

B. Related Sections:
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. ISA: Instrumentation Systems and Automation Society.
   4. NFPA: National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

A. Furnish all instruments as identified on the P&IDs and instrument lists shown on mechanical equipment lists.

B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.

C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor (ICSC).

1.5 CONTRACTOR SUBMITTALS

A. Furnish complete submittals in accordance with Section 01 33 20.

B. Product Data:

1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
2. Completed instrument data sheets including catalog number and source for determining catalog number.
3. Manufacturer's installation instructions.

C. Shop Drawings:
1. Mechanical connection diagrams.
2. Sensor transducer mounting requirements with dimensions and elevations.
3. Electrical connection diagrams.

D. Record Drawings:
1. Complete field calibration sheets, including range, span, PLC/PAC I/O address, register, and scaling coefficients.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated storage structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.

1.7 PROJECT/SITE CONDITIONS

A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.8 WARRANTY

A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. As identified on the instrument data sheets.

B. Hardware Commonality:
1. All instruments which utilize a common measurement principle, for example, d/p cells, pressure transmitters, level transmitters which monitor hydrostatic head, shall be furnished by a single Manufacturer.
2. All panel mounted instruments shall have matching style and general appearance.
3. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single Manufacturer.

2.2 EQUIPMENT

A. Level Switch, Electrode Probe and Relay
1. Probe switches shall be of the induction or conduction type.

2. Where electrode probed length is over 6-feet, electrodes shall be stainless steel supported by suspension cables, terminated at vendor-supplied electrode fittings in a watertight housing.
    a. Where electrode length is less than 6-feet, electrodes shall be stainless steel rods insulated with a Teflon sheath.
    b. Type 316 stainless steel electrodes shall be used in all cases except where the process liquid will attack stainless steel, for example stainless steel may not be used with ferric chloride.
    c. Probe switches as manufactured by:
        1) Gems-Warrick Series 3L
        2) Or, Engineer Approved Equal
    d. Cable type electrodes as manufactured by:
        1) Gems type Series 3Y.
        2) Or, Engineer Approved Equal
3. Induction Relay: Each induction relay shall be a combination of a matched transformer and relay, integrally mounted on a common base-plate and connected to a number of electrodes as shown.
    a. Transformer secondary voltage shall be as required by the liquid material.
    b. Enclosure shall be NEMA 4X.
    c. Switch rating shall be a minimum 5 amps at 24 VDC, 60 Hz.
    d. Field selectable sensitivity shall be provided.
    e. Induction relays as manufactured by:
        1) Gems Series 1.
        2) Or, Engineer Approved Equal.
    f. Single electrode relays as manufactured by:
        1) Gems Series 16VM.
        2) Or, Engineer Approved Equal.

B. Tipping Float
1. Float actuated switch shall be a dry contact type switch in a hermetically sealed polypropylene casing, suspended on a PVC coated cable.
2. The number of floats per level system shall be as shown.
3. The switch rating shall be at least 5 amps at 120 VAC.
4. Switch setpoints shall be as shown on the drawings
5. Mercury switch type capsules are not allowed.
6. As manufactured by:
    a. Anchor Scientific Mini-Float.
    b. Dwyer CFS2 Series or Dwyer FSW2 Series

C. Reed
1. The float, which contains a small magnet, is lifted by the liquid. As the magnet passes the reed switch, the switch opens.
    a. SPST dry reed switch potted into the float stem.
2. Enclosure.
    a. Epoxy coated die cast aluminum, NEMA 4 integrity.
3. Mechanical construction:
    a. Housing Gaskets: Neoprene.
    b. Thread Size: 2-inch NPT.
    c. Fitting material: PVC.

d. Rod material: PVC
e. Float Stem Material: PVC.
f. Float material: Buna-N

4. Operating parameters:
   a. Pressure: 125 psig.
   b. Temperature:
      1) Buna- N float +180°F.
      2) PVC +240°F.
   c. Specific gravity:
      1) Buna- N float liquid over 0.6.
      2) Stainless Steel Float liquid over 0.8.
5. Contact Rating:
   a. 50 watts (1/2 amp max switching current).
6. As manufactured by:
   a. Gems LS-800PVC.

D. Flood Switch
1. SPST dry reed switch potted into the float stem.
2. The float, which contains a small magnet, is lifted by the liquid. As the magnet passes the reed switch, the switch opens.
3. Housing: Epoxy coated die cast aluminum, NEMA 4 integrity.
4. Housing Gaskets: Neoprene.
5. Thread Size: 2" - 11 ½ NPT.
6. Pressure: 125 psig.
7. Temperature:
   a. Buna- N float +180°F.
   b. Stainless Steel Float +240°F.
8. Contact Rating: 50 watts (1/2 amp max switching current).
9. Specific gravity:
   a. Buna- N float liquid over 0.6.
   b. Stainless Steel Float liquid over 0.8.
10. Fitting material: 316 Stainless Steel.
11. Rod material: 304 Stainless Steel.
12. Float Stem Material: 316 Stainless Steel.
13. Float material: Buna-N.
14. As manufactured by:
   a. Gems LS-1700 Series.
   b. Gems LS-270 Series.
   c. Dwyer F7 Series.
   d. Or, Engineer Approved Equal.

E. Tuning Fork.
1. The frequency shift tuning operates based on resonant changes between the forks based on the forks being covered or uncovered.
   a. DPDT dry reed switch potted into the float stem.
2. Enclosure.
   a. Epoxy coated die cast aluminum, NEMA 4X integrity.
3. Mechanical construction:
   a. Housing Gaskets: Neoprene.

b. Thread Size: 2"NPT.
c. Fitting material: 316 Stainless Steel.
d. Stem Material: Polyester.

4. Contact Rating:
   a. 50 watts (1/2 amp max switching current).
5. As manufactured by:
   a. Endress+Hauser Liquidphant FTM50 Series.
   b. Dwyer Series TFLS
   c. Dwyer Model CTF.
   d. Or, Engineer Approved Equal.

2.3 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated to in facilities and with instruments traceable to the National Bureau of Standards.
   1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

A. Coordinate the installation with all trades to insure that the mechanical system has all necessary appurtenances, including weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacturer's recommendations.
   1. It is the ICSC's responsibility to install all instruments in conformance with manufacturer's recommendations.
   2. It is the ICSC's responsibility to notify the Engineer of any installation conditions that may be shown at variance with the manufacturer's recommendations

3.4 FIELD QUALITY CONTROL

A. The ICSC shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 61 00.

3.5 ADJUSTING

A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the Engineer prior to commissioning.

B. All instrument calibration shall be witnessed by the Owner's Representative.

C. Each and every instrument shall be tested during the Loop Validation Tests and the Owner's Representative shall witness the response in the PLC/PAC control system and associated registers.

3.8 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. The Contractor shall replace any instruments damaged prior to commissioning.
   1. The Engineer shall be the sole party responsible for determining the corrective measures.

3.9 SCHEDULES

A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the ICSC's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review at no additional costs to the Owner.

B. The ICSC shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with Paragraph 1.5 of this section.
   1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

SECTION 40 73 13
PRESSURE GAUGES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Instruments for instrumentation and control systems that are to be permanently installed.

B. Related Sections:
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society..

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. ISA: Instrumentation Systems and Automation Society.
   4. NFPA: National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

A. Furnish all instruments as identified on the P&IDs and instrument lists shown on mechanical equipment lists.

B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.

C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor (ICSC).

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 20.

B. Product Data:
   1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
   2. Completed instrument data sheets including catalog number and source for determining catalog number.

3. Manufacturer's installation instructions.

C. Shop Drawings:
   1. Mechanical connection diagrams.
   2. Sensor mounting requirements with dimensions and elevations.
   3. Electrical connection diagrams.

D. Test Reports:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.

E. Operating Manuals:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.
   2. Complete installation, calibration, and testing manuals.

F. Record Drawings:
   1. Complete field calibration sheets, including range, span.

1.6 QUALITY ASSURANCE

A. All instruments of similar nature must be furnished by the same manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated storage structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
   1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.

1.8 PROJECT/SITE CONDITIONS

A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

A. Provide all necessary materials, fluids, etc. for calibration purposes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Ashcroft 1279 w/ Performance Plus.

B. NoShok 600/700 Series.

C. Dwyer Series 765 or Series 7000B.

D. Wika USA XSEL Series.

E. Or, Engineer Approved Equals.

2.2 MANUFACTURED UNITS

A. Pressure, Vacuum, Compound Gauges.
   1. General.
      a. Furnish and install pressure and vacuum gauges as specified, complete, including all fittings, snubbers, connections, gaskets, supports, and accessories in the locations shown or specified, in accordance with the Contract Documents.
      b. Pressure gauges shall be provided whether or not shown on the plans:
         1) On suction and discharge connection to all pumps.
         2) On discharge connection from blowers and compressors.
         3) On each side of pressure reducing valves.
         4) In other locations as shown on the P&IDs and/or mechanical plans.
      c. Vacuum gauges shall be provided whether or not shown on the plans:
         1) On all supply side educator-type chemical feeders.
         2) In other locations as shown on the P&IDs and/or mechanical plans.
      d. Sleeve pressure gauges.
         1) Shall be provided where shown on the plans.
         2) Pressure shall be sensed by a flexible sleeve contained in a flanged cast iron or steel spool or wafer body, and transmitted to the gauge through a captive fluid.
         3) Sleeve shall be of BUNA-A and fabricated so as to isolate the body from the process liquid.
         4) Gauges shall be calibrated to read in applicable units.
         5) Accuracy of ±1% - 150% of the working pressure of the system to which they are connected
   2. Construction:
      a. Gauges shall be industrial quality type with Type 316 stainless steel movement.
      b. Phenolic case.
      c. Liquid filled.
      d. Unless otherwise shown or specified, gauges shall have:
         1) A 4-1/2-inch dial.
         2) 1/2-inch threaded connection.
         3) Type pulsation dampener adapter.

a) Pulsation Dampener as manufactured by:
b) Cajon Co.
c) Weksler Instruments, Corp.
d) Ashcroft.
e) Or, Engineered Approved Equal.

4) A block and bleed valve - 1/2 inch national pipe thread process connection and bleed/calibrate valve between block valve and outlet port.

e. Gages shall be calibrated to read in applicable engineering units.
f. Accuracy of ± 0.5% - 150 % of the working pressure or vacuum of the pipe or vessel to which they are connected.
g. All gauges shall be vibration and shock resistant.

3. Diaphragm seals:
   a. Gauges attached to system involving chemical solutions, corrosive fluids, sludge, sewage, or other liquids containing solids shall be equipped with diaphragm seals.
   b. In addition diaphragm seals shall be provided and included at the locations shown.
   c. Seals shall have clamped housings.
   d. All seals shall have 1/2 inch NPT flushing connection and fluid fill connection.
   e. Diaphragm Seals as manufactured by:
      1) Ashcroft Type 101.
      2) Ametek Type S Series.
      3) NoShok Type 10/10H.
      4) Or, Engineer Approved Equal.
4. Gauges general as manufactured by:
   a. Ashcroft Type 1279 w/ Plus Performance.
   b. Dwyer Series 7000B.
   c. Wika XSEL Model 212.34 (213.34 as required).
   d. Ametek Model 1929.
   e. NoShok 700 Series.
   f. Or, Engineer Approved Equal.
5. Gauges sleeve pressure as manufactured by:
   a. Red Valve Co., Inc.
   b. Onyx.
   c. NoShok Type 40.
   d. Or, Engineer Approved Equal.
6. Snubbers as manufactured by:
   a. Ashcroft, Model 311.
   b. Dwyer, Series PS.
   c. NoShok, Model 5025/5050
   d. Or, Engineer Approved Equal.
7. Pulsation dampeners as manufactured by:
   a. Cajon Co.
   b. Weksler Instruments, Corp.
   c. Ashcroft.
   d. Or, Engineer Approved Equal.

2.3 ACCESSORIES

A. Gauges shall be liquid filled or have some equivalent anti-vibration/-bounce technology.

2.4 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated to in facilities and with instruments traceable to the National Bureau of Standards.
   1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

A. Coordinate the installation with all trades to insure that the mechanical system has all necessary appurtenances. Weld-o-lets, valves, orientation, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
   1. It is the Contractor's responsibility to install all instruments in conformance with manufacturer's recommendations.
   2. It is the Contractor's responsibility to notify the Engineer of any installation conditions that may be shown at variance with the manufacturer's recommendations
   3. Install two 2-valve instrument manifolds for each gauge pressure transmitter.
   4. Bolt 3-valve manifolds at non-flange diaphragm type differential pressure transmitters in place of standard flange adapters.
   5. Install root valves at process taps except insertion elements.
   6. Install gauge valves on process connections to instruments where multiple instruments are connected to one tap or where root valves are not readily accessible.
   7. All gauges shall be installed with the face in the vertical position.
   8. In strict accordance with the manufacturers printed instructions.
   9. At the locations shown on the drawings, when so shown.
   10. Care shall be taken to minimize the effect of water hammer or vibrations on the gauges.
   11. In extreme cases, and with the approval of the Engineer, gauges may be mounted independently, with flexible connectors.

3.4 FIELD QUALITY CONTROL

A. The ICSC shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 61 00.

3.5 ADJUSTING

A. All instruments shall be field verified.

3.6 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the Engineer prior to commissioning.

3.7 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. The Contractor shall replace any instruments damaged prior to commissioning.
   1. The Engineer shall be the sole party responsible for determining the corrective measures.

3.8 SCHEDULES

A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the Contractor's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review. The Contractor shall provide documented evidence for a differential plus or minus that results from these changes.

B. The Contractor shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with Paragraph 1.5 of this section.
   1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

SECTION 40 73 26
PRESSURE-TRANSMITTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Instruments for instrumentation and control systems that are to be permanently installed.

B. Related Sections
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. ISA: Instrumentation Systems and Automation Society.
   4. NFPA: National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

A. Furnish all instruments as identified on the P&IDs and instrument lists shown on mechanical equipment lists.

B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.

C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor (ICSC).

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 20.

B. Product Data:
   1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
   2. Completed instrument data sheets including catalog number and source for determining catalog number.

3. Manufacturer's installation instructions.

C. Shop Drawings:
   1. Mechanical connection diagrams.
   2. Sensor transducer mounting requirements with dimensions and elevations.
   3. Electrical connection diagrams.

D. Test Reports:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.

E. Operating Manuals:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.
   2. Complete installation, calibration, and testing manuals.

F. Record Drawings:
   1. Complete field calibration sheets, including range, span, PLC/PAC I/O address, register, and scaling coefficients.

1.6 QUALITY ASSURANCE

A. All instruments of similar nature must be furnished by the same manufacturer.

B. Manufacturer's representative shall be responsible for proving transmitter operation and 4-20 ma loop accuracy.

C. Instruments shall be manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated van or structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
   1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.

1.8 PROJECT/SITE CONDITIONS

A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

A. Provide all necessary materials, fluids, etc. for calibration purposes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. As identified on the instrument data sheets.

B. Hardware Commonality:
   1. All instruments, which utilize a common measurement principle, for example, d/p cells, pressure transmitters, level transmitters that monitor hydrostatic head, shall be furnished by a single Manufacturer.
   2. All panel-mounted instruments shall have matching style and general appearance.
   3. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single Manufacturer.

2.2 EQUIPMENT

A. Pressure Transmitters Direct
   1. General
      a. Pressure transmitters shall be 2-wire devices.
      b. Continuously adjustable span, zero and damping adjustments.
      c. Integral LCD meter scaled in engineering units.
      d. Solid state circuitry.
      e. Accuracy shall be ± 0.20% of span.
      f. Process wetted materials as identified on Instrument Data Sheets.
      g. Body material as identified on Instrument Data Sheets.
      h. Process connections shall be 1/2-inch NPT.
      i. Diaphragm seals shall be provided and included at the locations shown.
      j. Rangeability: 20:1.
      k. Integral transient protection.
      l. Factory calibrated for span and range.
   2. Ranges:
      a. As noted on the Instrument Data Sheets
   3. As manufactured by:
      a. Rosemount Model 3051.
      b. Endress+Hauser Cerabar Series.
      c. Kobold PAS Heavy-Duty Series.
      d. Foxboro IGP/IAP Series.
      e. Azbil AT9000 Series.
      f. Or, Engineer Approved Equals.

B. Pressure Transmitters - Differential
   1. General
      a. Continuously adjustable span, zero and damping adjustments.
      b. Integral LCD meter scaled in engineering units.
      c. Solid state circuitry.

d. Accuracy shall be ± 0.20 percent of span.
e. Process wetted materials as identified on Instrument Data Sheets.
f. Body material as identified on Instrument Data Sheets.
g. Process connections shall be 1/2-inch NPT.
h. Diaphragm seals shall be provided and included at the locations shown.
i. Rangeability: 20:1.
j. Integral transient protection.
k. Factory calibrated for span and range.

2. Ranges:
   a. As noted on the Instrument Data Sheets

3. As manufactured by:
   a. Rosemount Model 3051.
   b. Endress+Hauser Deltabar Series.
   c. Kobold PAD Heavy-Duty Series.
   d. Foxboro IDP Series.
   e. Azbil AT9000 Series.
   f. Or, Engineer Approved Equals.

2.3 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated to in facilities and with instruments traceable to the National Bureau of Standards.
   1. Provide complete documentation covering the traceability of all calibration instruments.
   2. Provide 3 copies of calibration curve – One with the instrument, one to the engineer and a third copy in the O&M located with its corresponding ISA data sheet. Calibration curve shall be matched by instrument tag.

B. Manufacturer's representative shall be responsible for proving flow meter operation and 4-20 mA loop accuracy.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

A. Coordinate the installation with all trades to insure that the mechanical system has all necessary appurtenances, weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacture's recommendations.

1. It is the Contractor's responsibility to install all instruments in conformance with manufacturer's recommendations.
2. It is the Contractor's responsibility to notify the Engineer of any installation conditions that may be shown at variance with the manufacturer's recommendations

3.4 FIELD QUALITY CONTROL

A. The ICSC shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 61 00.

3.5 ADJUSTING

A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the Engineer prior to commissioning.

B. All instrument calibration shall be witnessed by the Owner's Representative.

C. Each and every instrument shall be tested during the Loop Validation Tests and the Owner's Representative shall witness the response in the PLC/PAC control system and associated registers.

3.8 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. The Contractor shall replace any instruments damaged prior to commissioning.
1. The Engineer shall be the sole party responsible for determining the corrective measures.

3.9 SCHEDULES

A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the Contractor's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review. The Contractor shall provide documented evidence for a differential plus or minus that results from these changes.

B. The Contractor shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with paragraph 1.5 of this section.
1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

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SECTION 40 73 37
PRESSURE-SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Instruments for instrumentation and control systems that are to be permanently installed.

B. Related Sections
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. ISA: Instrumentation Systems and Automation Society.
   4. NFPA: National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

A. Furnish all instruments as identified on the P&IDs and instrument lists shown on mechanical equipment lists.

B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.

C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor (ICSC).

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 20.

B. Product Data:
   1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
   2. Completed instrument data sheets including catalog number and source for determining catalog number.

3. Manufacturer's installation instructions.

C. Shop Drawings:
   1. Mechanical connection diagrams.
   2. Sensor transducer mounting requirements with dimensions and elevations.
   3. Electrical connection diagrams.

D. Test Reports:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.

E. Operating Manuals:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.
   2. Complete installation, calibration, and testing manuals.

F. Record Drawings:
   1. Complete field calibration sheets, including range, span, PLC/PAC I/O address, register, and scaling coefficients.

1.6 QUALITY ASSURANCE

A. All instruments of similar nature must be furnished by the same manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated storage structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
   1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the OWNER.

1.8 PROJECT/SITE CONDITIONS

A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

A. Provide all necessary materials, fluids, etc. for calibration purposes.

PART 2 - – PRODUCTS

2.1 MANUFACTURERS

A. SOR Series V1.

B. Mercoid Series CS.

C. Ashcroft NPA-Series.

D. United Electric Series 400.

E. Or, Engineer Approved Equal.

2.2 MANUFACTURED UNITS

A. Pressure Switches.
   1. General:
      a. Enclosure NEMA 4X.
      b. Manual Reset trip on increasing pressure.
      c. Relay Switches shall be DPDT.
      d. Actuator Seal: Teflon (verify with manufacturer for each and every installation)
      e. Each pressure switch shall have visible scale and contact operation.
   2. Pressure switches shall have a contact rating of 10 Amps at 125 VAC.
   3. Pressure switches shall be snap-action switches and shall be in general-purpose enclosures at indoor installations, or weatherproof enclosures at outdoor installations.
   4. Diaphragm seals shall be provided and included at the locations indicated in the drawings.
   5. Any pressure switch used to detect high pump discharge shall be equipped with a manual reset.

B. Differential Pressure Switches.
   1. General
      a. NEMA 4X.
      b. Variable Deadband.
      c. Actuator Seal - Viton 20°F to 300°F (-6°C to 149°C) (verify with manufacturer for each and every installation).
      d. Relay switch shall be DPDT.
      e. Each pressure switch shall have visible scale and contact operation.
      f. Pressure switches shall have a contact rating of 10 Amps at 125 VAC.
      g. Pressure switches shall be snap-action switches and shall be in general-purpose enclosures at indoor installations, or weatherproof enclosures at outdoor installations.
      h. Diaphragm seals shall be provided and included at the locations shown.
   2. Automatic reset.
   3. Adjustable differential.

2.3 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated to in facilities and with instruments traceable to the National Bureau of Standards.
   1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 - – EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

A. Coordinate the installation with all trades to insure that the mechanical system has all necessary appurtenances, weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
   1. It is the CONTRACTOR's responsibility to install all instruments in conformance with manufacturer's recommendations.
   2. It is the CONTRACTOR's responsibility to notify the ENGINEER of any installation conditions that may be shown at variance with the manufacturer's recommendation.

3.4 FIELD QUALITY CONTROL

A. The ICSC shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 61 00.

3.5 ADJUSTING

A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the ENGINEER prior to commissioning.

B. All instrument calibration shall be witnessed by the OWNER's Representative.

C. Each and every instrument shall be tested during the Loop Validation Tests and the OWNER's Representative shall witness the response in the PLC/PAC control system and associated registers.

3.8 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. The CONTRACTOR shall replace any instruments damaged prior to commissioning at no additional cost to the OWNER.
   1. The ENGINEER shall be the sole party responsible for determining the corrective measures.

3.9 SCHEDULES

A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the CONTRACTOR's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review. The CONTRACTOR shall provide documented evidence for a differential plus or minus that results from these changes.

B. The CONTRACTOR shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with paragraph 1.5 of this section.
   1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

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SECTION 40 73 38
HAZARDOUS AND COMBUSTIBLE GAS MONITORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Instruments for instrumentation and control systems that are to be permanently installed.

B. Related Sections
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. National Electrical Code.
   2. Institute of Electrical and Electronic Engineers.
   3. Instrumentation Systems and Automation Society.
   4. National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

A. Furnish all instruments as identified on the P&IDs and instrument lists shown on mechanical equipment lists.

B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.

C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor.

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 20.

B. Product Data:
   1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
   2. Completed instrument data sheets including catalog number and source for determining catalog number.

3. Manufacturer's installation instructions.

C. Shop Drawings:
   1. Mechanical connection diagrams.
   2. Sensor transducer mounting requirements with dimensions and elevations.
   3. Electrical connection diagrams.

D. Test Reports:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.

E. Operating Manuals:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.
   2. Complete installation, calibration, and testing manuals.

F. Record Drawings:
   1. Complete field calibration sheets, including range, span, PLC I/O address, register, and scaling coefficients.

1.6 QUALITY ASSURANCE

A. All instruments of similar nature must be furnished by the same manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated van or structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
   1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the OWNER.

1.8 PROJECT/SITE CONDITIONS

A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

A. Provide all necessary materials, fluids, etc. for calibration purposes.

PART 2 - – PRODUCTS

2.1 MANUFACTURERED UNITS

A. Combustible Gas (Hydrocarbons typical to the wastewater treatment plant environment, including, but not limited to methane, etc.).

1. Device identifications: See project bid documentation.
2. General
   a. The combustible gas monitoring system shall include one on board "Catalytic" Gas Monitoring device and one graphical interface unit.
   b. Measuring Ranges and Resolution: 0-100% LEL and 1% LEL resolution
   c. Accuracy: <±3% 0-50% LEL, <±5% 51-100% LEL
   d. Repeatability: <5% of signal
   e. Long Term Drift: <0.05% of signal/month
   f. Response time to Alarm: T50: <10 seconds; T90
   g. Display: 4 digit, 7 segment, red LED
   h. Temperature and Humidity: Temperature -20°C ~ ±50°C; (Intermittent Operation) -40°C ~ ±60°C and Humidity 15% - 90%
   i. Power Supply (input voltage and current): 24 VDC (12-28 VDC), 150 mA (nominal)
   j. Analog Signal - Include the 4-20 mA Output Signal option: 2-wire or 3-wire interface 1000 ohms @ 24 VDC, 500 ohms @ 12VDC User programmable scaling
   k. Alarms: User programmable low and high alarms, fault; Display indication for alarms.
   l. Relays: Three (3) SPST, normally open relays; Contact Capacity: 5 A at 120/250 VAC or 30 VDC
   m. Calibration Interface: Magnetic wand (non-intrusive) and Microprocessor Controlled
   n. Programming and set up interface: Push button
   o. Wire Terminations: Screw down terminals (18-24 AWG) and 18 AWG (1 mm) shielded cable recommended
3. Approvals
   a. NRTL & CSA
   b. UL Std No: 916-Energy Management Equipment
   c. UL Std No: 1203-Explosion-Proff and Dust-Ignition-Proof
   d. Electrical Equipment for Use in Hazardous (Classified) Locations
   e. CSA Std C22.2 No. 30-M1986-Explosion-Proof Enclosures for use in Class I Hazardous Locations
   f. CSA Std C22.2 No. 142-M1987-Process Control Equipment
   g. IEC & ATEX: EEx d IIB+H2 T4
   h. EN50014; EN50018; EN50270; EMC EN55022, EN50082-2:1995 Lower Voltage EN 60335-1 Part IL 1994 and 11: 1995
4. Enclosure (main electronics unit): Material: Cast-Aluminum Explosion-proof Class: Class 1, Div 1 & 2 Group B, C, D
5. Sensor Housing Material: Aluminum, Anodized
6. The monitor shall be:
   a. Honeywell, Sensepoint XCD
   b. Sensidyne, SensAlert ASI or SensAlert PLUS
   c. MSA, Ultima XE Series

d. Industrial Scientific-Oldham, iTrans or iTrans2
e. Or, Engineer Approved Equal

B. Hydrogen Sulfide (H_2S)
1. Device identifications: See project bid documentation.
2. General
a. The hazardous gas (H_2S) monitoring system shall include one on board electro-chemical Gas Monitoring device and one graphical interface unit.
b. Measuring Ranges and Resolution: 0 – 50 ppm, 0-100% LEL; 1% LEL resolution
c. Accuracy:<±3% 0-50% LEL, <±5% 51-100% LEL
d. Repeatability:<5% of signal
e. Long Term Drift: <0.05% of signal/month
f. Response time to Alarm: T50: <10 seconds and T90: <30 seconds
g. Display:4 digit, 7 segment, red LED
h. Temperature and Humidity: Temperature -20°C ~ ±50°C, (Intermittent Operation) -40°C ~ ±60°C and Humidity 15% - 90%
i. Power Supply (input voltage and current): 24 VDC (12-28 VDC), 150 mA (nominal)
j. 4-20 mA Output Signal: 2-wire or 3-wire interface 1000 ohms @ 24 VDC, 500 ohms @ 12VDC User programmable scaling
k. Alarms: User programmable low and high alarms, fault, Display indication for alarms
l. Relays: Three (3) SPST, normally open relays
m. Contact Capacity: 5 A at 110VAC or 30 VDC
o. Calibration Interface:Magnetic wand (non-intrusive) Microprocessor Controlled
n. Programming and set up interface:Push button
o. Wire Terminations: Screw down terminals (18-24 AWG) and 18 AWG (1 mm) shielded cable recommended
3. Approvals:
a. NRTL & CSA
b. UL Std No: 916-Energy Management Equipment
c. UL Std No: 1203-Explosion-Proff and Dust-Ignition-Proof
d. Electrical Equipment for Use in Hazardous (Classified) Locations
e. CSA Std C22.2 No. 30-M1986-Explosion-Proof Enclosures for Use in Class I Hazardous Locations
f. CSA Std C22.2 No. 142-M1987-Process Control Equipment
g. IEC & ATEX: EEx d IIB+H2 T4
h EN50014; EN50018; EN50270; EMC EN55022 EN 50082-2: 1995 Lower Voltage EN 60335-1 Part IL 1994 and 11: 1995
4. Enclosure (main electronics unit):
a. Material: Cast-Aluminum
b. Explosion-proof Class: Class 1, Div 1 & 2 Group B, C, D
c. Sensor Housing Material: Aluminum, Anodized
5. The monitor shall be:
a. Honeywell, Sensepoint XCD
b. Sensidyne, SensAlert ASI or SensAlert PLUS
c. MSA, Ultima XE Series

d. Industrial Scientific-Oldham, iTrans or iTrans2
e. Or, Engineer Approved Equal

2.2 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated to in facilities and with instruments traceable to the National Bureau of Standards.
1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 - – EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

A. Coordinate the installation with all trades to insure that the electrical and mechanical systems have all necessary equipment for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
1. It is the CONTRACTOR's responsibility to install all instruments in conformance with manufacturer's recommendations.
2. It is the CONTRACTOR's responsibility to notify the ENGINEER of any installation conditions that may be shown at variance with the manufacturer's recommendation.

3.4 FIELD QUALITY CONTROL

A. The Instrumentation and Control Systems Contractor shall calibrate all instruments in the field during the Calibration and Loop Validation Tests.

3.5 ADJUSTING

A. All instruments shall be field calibrated to match the installed conditions.

3.6 CALIBRATION KIT

A. Provide one calibration kit for each type of gas monitor being provided with all appropriate sample gas, hoses and required equipment to properly calibrate the monitoring units. Must be a manufacturer's recommended or approved calibration kit.

3.7 CLEANING

A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.8 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the ENGINEER prior to commissioning.

B. All instrument calibration shall be witnessed by the OWNER's Representative.

C. Each and every instrument shall be tested during the Loop Validation Tests and the OWNER's Representative shall witness the response in the PLC control system and associated registers.

3.9 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. The CONTRACTOR shall replace any instruments damaged prior to commissioning at no additional cost to the OWNER.
   1. The ENGINEER shall be the sole party responsible for determining the corrective measures.

3.10 SCHEDULES

A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the CONTRACTOR's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review. The CONTRACTOR shall provide documented evidence for a differential plus or minus that results from these changes.

B. The CONTRACTOR shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with paragraph 1.5 of this section.
   1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

SECTION 40 74 63
TEMPERATURE-TRANSMITTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Instruments for instrumentation and control systems that are to be permanently installed.

B. Related Sections
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. ISA: Instrumentation Systems and Automation Society.
   4. NFPA: National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

A. Furnish all instruments as identified on the P&IDs and instrument lists shown on mechanical equipment lists.

B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.

C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor (ICSC).

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 20.

B. Product Data:
   1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
   2. Completed instrument data sheets including catalog number and source for determining catalog number.

3. Manufacturer's installation instructions.

C. Shop Drawings:
   1. Mechanical connection diagrams.
   2. Sensor transducer mounting requirements with dimensions and elevations.
   3. Electrical connection diagrams.

D. Test Reports:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.

E. Operating Manuals:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
   2. Including factory calibration for each instrument with stated accuracy.
   3. Complete installation, calibration, and testing manuals.

F. Record Drawings:
   1. Complete field calibration sheets, including range, span, PLC/PAC I/O address, register, and scaling coefficients.

1.6 QUALITY ASSURANCE

A. All instruments of similar nature must be furnished by the same manufacturer.

B. Manufacturer's representative shall be responsible for proving all 4-20ma loops.

C. Instruments shall be manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated van or structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
   1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the OWNER.

1.8 PROJECT/SITE CONDITIONS

A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 SEQUENCING AND SCHEDULING

1.10 WARRANTY

A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.11 MAINTENANCE

A. Provide all necessary materials, fluids, etc. for calibration purposes.

PART 2 - – PRODUCTS

2.1 MANUFACTURERS

A. For Process non-hazardous environments:
   1. Relative Humidity Range: 0% - 100% Relative Humidity (RH)
   2. Wall Mountable
   3. Temperature Range: -40°F – 140°F
   4. Accuracy : ±3%
   5. 4-20 mA Loop-powered
   6. Output: 4-20 mA
   7. As manufactured by:
      a. Georg+Fischer Signet 8350 w/ Signet 2350 Sensor.
      b. Omega PRTXD Series w/ integral sensor.
      c. Dwyer model RHT-O or RHT-W.
      d. Or, Engineer Approved Equal.

B. For Process Hazardous environments:
   1. Relative Humidity Range: 0% - 100% RH
   2. Wall Mountable
   3. Temperature Range: -40°F – 140°F
   4. Explosion proof
   5. Accuracy : ±2%
   6. 4-20 ma Loop-powered
   7. Output: 4-20 mA
   8. As manufactured by:
      a. Dwyer model HHT-EX for Class 1 Div 1 areas (Explosion Proof)
      b. No equal.

C. For indoor, temperature only:
   1. Temperature only, indoor air, NEMA Type 1.
   2. Wall Mountable.
   3. Temperature Range: 0°F – 135°F.
   4. The temperature transmitters shall be 24VDC loop-powered.
   5. Output 4-20 mA.
   6. Manufacturer and Model Number.
      a. Omega EWS-TX.
      b. Or, Engineered Approved Equal.

D. For outdoor location, temperature only:
   1. Temperature only, outdoor air, NEMA Type 4X.
   2. Wall Mountable.
   3. Temperature Range: -40°F – 185°F.
   4. The temperature transmitters shall be 24VDC loop-powered.

5. Output 4-20 mA.
6. Manufacturer and Model Number.
    a. Omega EWSE-PT100-TX
    b. Or, Engineer Approved Equal.

2.2 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated to in facilities and with instruments traceable to the National Bureau of Standards.
    1. Provide complete documentation covering the traceability of all calibration instruments.
    2. Provide 3 copies of calibration curve – One with the instrument, one to the engineer and a third copy in the O&M located with its corresponding ISA data sheet. Calibration curve shall be matched by instrument tag.

PART 3 - – EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

A. Coordinate the installation with all trades to insure that the mechanical system has all necessary appurtenances, weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
    1. It is the CONTRACTOR's responsibility to install all instruments in conformance with manufacturer's recommendations.
    2. It is the CONTRACTOR's responsibility to notify the ENGINEER of any installation conditions that may be shown at variance with the manufacturer's recommendations

3.4 FIELD QUALITY CONTROL

A. The ICSC shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 61 00.

3.5 ADJUSTING

A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the ENGINEER prior to commissioning.

B. All instrument calibration shall be witnessed by the OWNER's Representative.

C. Each and every instrument shall be tested during the Loop Validation Tests and the OWNER's Representative shall witness the response in the PLC/PAC control system and associated registers.

3.8 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. The CONTRACTOR shall replace any instruments damaged prior to commissioning.
   1. The ENGINEER shall be the sole party responsible for determining the corrective measures.

3.9 SCHEDULES

A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the CONTRACTOR's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review. The CONTRACTOR shall provide documented evidence for a differential plus or minus that results from these changes.

B. The CONTRACTOR shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with paragraph 1.5 of this section.
   1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

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SECTION 40 75 13
ANALYZERS-PH/ORP

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Instruments for instrumentation and control systems that are to be permanently installed.

B. Related Sections:
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. ISA: Instrumentation Systems and Automation Society.
   4. NFPA: National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

A. Furnish all instruments as identified on the P&IDs and instrument lists shown on mechanical equipment lists.

B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.

C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor (ICSC).

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 20.

B. Product Data:
   1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
   2. Completed instrument data sheets including catalog number and source for determining catalog number.

3. Manufacturer's installation instructions.

C. Shop Drawings:
   1. Mechanical connection diagrams.
   2. Sensor transducer mounting requirements with dimensions and elevations.
   3. Electrical connection diagrams.

D. Test Reports:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.

E. Operating Manuals:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.
   2. Complete installation, calibration, and testing manuals.

F. Record Drawings:
   1. Complete field calibration sheets, including range, span, PLC/PAC I/O address, register, and scaling coefficients.

1.6 QUALITY ASSURANCE

A. All instruments of similar nature must be furnished by the same manufacturer.

B. Manufacturer's representative shall be responsible for proving flow meter operation and 4-20 mA loop accuracy.

C. Instruments shall be manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated storage structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
   1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.

1.8 PROJECT/SITE CONDITIONS

A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

A. Provide all necessary materials, fluids, etc. for calibration purposes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS, OR EQUAL

A. HACH SC1000/200 Transmitter w/ PD1, RD1 or PC1 Sensors.

B. ECD T80 Transmitter w/ PHS80 or MVS80 Sensors.

C. Georg+Fischer Signet 8900 w/ Signet 2724-2726 or 2774-2777 Sensors.

D. YSI Online Sensors

E. Or, Engineered Approved Equal.

2.2 MANUFACTURED UNITS

A. pH or ORP Analyzer / Transmitter Systems
   1. Each pH/ORP analyzer/transmitter system shall consist of:
      a. An indicating analyzer / transmitter.
      b. Preamplifier.
      c. ORP or pH probe assembly.
      d. Mounting hardware.
      e. Interconnecting cables.
   2. The pH/ORP analyzer / transmitter shall continuously measure and indicate the pH of an aqueous solution.
      a. The analyzer shall produce a 4-20 mA DC output signal proportional to the measured pH/ORP over any 2 pH/+-1500 mV or greater span and be capable of delivering this output signal into a minimum load of 600 ohms.
      b. The analyzer shall produce a 4-20 mA DC output signal proportional to the measured pH/ORP and be capable of delivering this output signal into a minimum load of 600 ohms.
      c. The pH/ORP readings shall be automatically compensated for temperature variations from 32° to 200°F.
      d. Operating temperature: -4°F – 140°F (-20°C – 60°C).
         1) Mount electronics in a temperature controlled enclosure if the ambient temperature is outside the operating temperature range.
   3. The pH/ORP analyzer/transmitter shall be furnished in a NEMA Type 4X enclosure suitable for either surface or panel mounting.
   4. The system shall operate on 120 VAC or 24 VDC power source.
   5. The pH/ORP preamplifier shall be integral to a watertight pH probe assembly.
   6. The pH/ORP probe assembly shall contain:
      a. The pH/ORP measuring process electrode.
      b. Reference or standard electrode.

c. Automatic temperature-compensation circuit.
d. The pH/ORP probe assembly shall be suitable for submersion, insertion, or flow-through as required by the particular installation.
    1) The probe assembly shall be constructed of non-corrosive materials.
    2) It shall be supplied with mounting hardware and interconnecting cable of suitable length for proper installation and servicing of the probe assembly.
e. Consist of a threaded polypropylene body for maximum chemical resistance and completely sealed to eliminate process fluid intrusion.
f. Measured range 0 pH – 14 pH/-1500mV – +1500mV, respectively.
g. Wetted materials: Polypropylene, EPDM, Titanium, glass/platinum.
h. Process connection: 1" MNPT.
i. Temperature range: 32°F – 212°F (0°C – 100°C).
j. Pressure Range: 0 – 100 PSIG.

7. Each pH/ORP analyzer system shall be furnished with any additional chemicals, solutions and maintenance materials that are required for sustaining the system in continuous operation for one year.

2.3 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated to in facilities and with instruments traceable to the National Bureau of Standards.
    1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

A. Coordinate the installation with all trades to insure that the mechanical system has all necessary appurtenances. Weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
    1. It is the Contractor's responsibility to install all instruments in conformance with manufacturer's recommendations.
    2. It is the Contractor's responsibility to notify the Engineer of any installation conditions that may be shown at variance with the manufacturer's recommendations

3.4 FIELD QUALITY CONTROL

A. The ICSC shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 61 00.

3.5 ADJUSTING

A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the Engineer prior to commissioning.

B. All instrument calibration shall be witnessed by the Owner's Representative.

C. Each and every instrument shall be tested during the Loop Validation Tests and the Owner's Representative shall witness the response in the PLC/PAC control system and associated registers.

3.8 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. The Contractor shall replace any instruments damaged prior to commissioning.
   1. The Engineer shall be the sole party responsible for determining the corrective measures.

3.9 SCHEDULES

A. The Contractor shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with paragraph 1.5 of this section.
   1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

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SECTION 40 78 00
CONTROL PANEL-INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. General: This section sets forth the general specification and requirements for the devices that shall be located within and on control panels to form a complete and operable system.

B. Related Sections:
   1. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 DEFINITIONS

A. In accordance with Section 40 61 00 -- Process Control and Instrumentation Systems General.

1.3 SYSTEM DESCRIPTION

A. In accordance with Section 40 67 10, “Control Panel”.

B. Analog measurements and control signals shall:
   1. Be electrical as indicated herein, and shall vary in direct linear proportion to the measured variable, except as noted.
   2. Electrical signals outside control panels shall be 4-20 mA DC, except as noted.
   3. Signals within enclosures may be 4-20 mA DC, except as noted.
   4. Dropping resistors shall be installed at all field side terminations in the control panels to ensure loop integrity, as required.

C. All control panels shall each be provided with power supplies which are configured to match the voltage and current requirements of the load.

D. Each 120 VAC control loop and instrument shall have an individual fuse or circuit breaker within its respective control panel and clearly identified for function.

E. Each 120 VAC and 24 VDC PLC output shall have its own individual fuse external of the I/O card, with blown fused indication.
   1. Size external fuse to open before any I/O card mounted fuses.

F. Signal Isolators, Signal Converters, and Power Supplies:
   1. Signal isolators shall be furnished and installed in each measurement and control loop, wherever required:
      a. To ensure adjacent component impedance match.
      b. Where feedback paths may be generated.
      c. To maintain loop integrity when the removal of a component of a loop is required.

2. Signal converters shall be included where required to resolve any signal level incompatibilities.

G. Separate signal power supplies shall be included, as required by the manufacturer's instrument load characteristics, to ensure sufficient power to each loop component.

1.4 SUBMITTALS

A. In accordance with:
1. Section 40 61 00, "Process Control and Instrumentation Systems General."
2. Refer to individual instrument and device specifications for additional submittal requirements.

B. Additional submittal requirements.
1. Circuit Breakers.
a. Provide a complete schedule showing load and rating of circuit breakers.
2. Control Fuses.
a. Provide a complete schedule and fuse coordination study.
3. Control Power Transformers.
a. Provide complete sizing calculations in accordance with the requirements of Control Power Section of this Specification Section.

1.5 ASSURANCE

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

1.6 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

1.7 PROJECT / SITE CONDITIONS

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

1.8 SEQUENCING AND SCHEDULING

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

B. All control panel testing shall be performed prior to shipping.

1.9 WARRANTY

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

1.10 MAINTENANCE

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

B. Spares

1. All unused inputs and outputs from the PLC/PAC shall be wired to field terminal blocks and identified.
2. Furnish one spare normally open and one spare normally closed dry contact for each push-button, selector switch, relay, etc.
3. Furnish five spare fuses for each and every fuse type in the panel.
4. Furnish 15 spare terminal blocks or 25%, whichever is greater.
5. All spare contacts of relays, switches, etc., shall be internally wired to terminal blocks.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. All panel-mounted instruments shall have matching style and general appearance.

B. Instruments performing similar functions shall be of the same type, model, or class, and shall be of one manufacturer.

2.2 COMPONENTS

A. Signal Isolators, Converters, and Power Supplies
1. Signal isolators shall be furnished and installed in each measurement and control loop, wherever required, to ensure adjacent component impedance match, or where feedback paths may be generated.
2. Signal converters shall be included where required to resolve any signal level incompatibilities.
3. Signal power supplies shall be included, as required by the manufacturer's instrument load characteristics, to ensure sufficient power to each loop component.
4. Signal isolators shall have complete isolation of input, output and power input.
    a. Signal input shall be 4-20 mA into 50 Ω, maximum.
    b. Signal output shall be 4-20 mA into 1000 Ω, minimum.
    c. Power input shall be 120 VAC, 60 Hz.
    d. Span and zero shall be adjustable.
    e. Accuracy shall be ±1 percent of span.
    f. Units shall be surface, DIN-rail, or rack mounted.
5. Acceptable manufacturers:
    a. Acromag.
    b. AGM Electronics Model TA-4000.
    c. Turck
    d. Or, Engineer Approved Equal.

B. Relays
1. General Purpose Relays:
    a. General purpose relays shall be plug-in type
    b. Contacts rated 10 Amps at 120 VAC
    c. With LED indication for energization
    d. With push-to-test button
    e. Quantity and type of contacts shall be as shown on the Drawings or as needed for system compatibility.

f. Each relay shall be enclosed in a clear plastic heat and shock resistant dust cover.
g. Sockets for relays shall have screw-type terminals.
h. Provide transient surge protection across the coil of each relay.
i. Relays shall be:
    1) Potter and Brumfield Type KRP or KUP.
    2) IDEC.
    3) Square D Type K.
    4) Allen Bradley.
    5) Or, Engineer Approved Equal.

2. Slave Interposing Relays:
    a. Additional slave relays shall be provided when the number or type of contacts shown exceed the contact capacity of the specified relays and timers.
    b. Additional relays shall be provided when higher contact rating is required to interface with starter circuits or other equipment.
    c. Shall be provided to compensate for voltage drop due to long wire runs.
    d. The slave and interposing relays shall be as the general-purpose relays.
    e. Provide transient surge protection across the coil of each relay.
3. Control Relays
    a. Including all electrically held relays, pneumatic time delay relays, mechanically latch relays, solid state time relays where the number of contacts exceed those available with the general-purpose relays.
    b. Convertible contact cartridges to convert any contact from a normally open to a normally closed configuration.
    c. Contact material shall be fine grade silver.
    d. Contact cartridges to be enclosed having a clear cover to allow for inspection of the contacts.
    e. Contact rating NEMA A600.
    f. Control Voltage 120 VAC.
    g. Provide transient surge protectors across the coil of each control relay.
    h. As manufactured by:
        1) Allen Bradley 700P.
        2) Square D850 Type X.
        3) Cutler Hammer AR.
        4) IDEC.
        5) SquareD.
        6) Or, Engineer Approved Equal.
4. Time Delay Relays
    a. Time delay relays shall be pneumatic on-delay or off-delay type.
    b. Contacts shall be rated 10 Amps at 120 VAC.
    c. Units shall include adjustable dial with graduated scale covering the time range in each case.
    d. Provide transient surge protection across the coil of each relay.
    e. As manufactured by:
        1) Agastat Series 7000.
        2) Allen-Bradley.
        3) IDEC.
        4) SquareD.
        5) Or, Engineer Approved Equal.

C. Digital Process Indicator
1. Digital process indicators shall be self-contained instruments that display process signals directly in engineering units.
2. The unit shall be suitable for panel mounting and shall utilize a seven segment LED display of not less than 0.56-inch height.
3. Features.
a. Multi-range capabilities.
b. Integral provisions for scaling.
c. Switch programmable decimal points.
4. NEMA 4 / IP65 sealed front metal bezel.
5. Current and Voltage loop indicators.
a. Current-loop indicators as shown on the drawings or as required by the instrumentation.
b. Voltage-loop indicators as shown on the drawings or as required by the instrumentation.
c. 3 ½ - digit.
d. Accuracy shall meet or exceed the following requirements.
1) DC Volts : ±0.1% of reading + 1 digit.
2) AC Volts : ±0.1% of reading + 2 digits (45-500 Hz).
3) DC Current :
a) 199.9µA : ±0.1% of reading + 1 digit.
b) 1.999mA : ±0.1% of reading + 1 digit.
c) 19.99mA : ±0.1% of reading + 1 digit.
d) 199.9mA : ±0.15% of reading + 1 digit.
e) 1.999A : ±0.5% of reading + 1 digit.
4) AC Current (45-500 Hz) :
a) 199.9µA : ±0.1% of reading + 2 digits.
b) 1.999mA : ±0.1% of reading + 2 digits.
c) 19.99mA : ±0.1% of reading + 2 digits.
d) 199.9mA : ±0.15% of reading + 2 digits.
e) 1.999A : ±0.5% of reading + 2 digits.
e. Ratings, protection, and indication:
1) Maximum voltage on terminal blocks 300 VAC or VDC.
2) Maximum voltage on basic range inputs 75 VAC ro VDC.
3) Maximum shunt current
a) For 199.9µA : 2 Ma.
b) For 1.999mA : 20 mA.
c) For 19.99mA : 200 mA.
d) For 199.9mA : 1 A.
e) For 1.999A : 3 A.
f. Power supply as indicated on the drawings or required by the system:
1) 120 VAC.
2) 230 VAC.
g. Operating Temperature
1) 32°F – 140°F (0° C to 60°C).

D. Manual Operator Interface Devices.
1. Control Components - Oil Tight

a. All operators, pushbutton, selector switches, and pilot lights are to be of the same manufacturer.
b. NEMA Type 13 oil-tight.
c. With synthetic rubber gasket.
d. Heavy duty.
e. Industrial grade full size 1-3/16" (30 mm) diameter.
f. Pushbutton units:
    1) Contacts rated
        a) NEMA A600
        b) 600 VAC maximum
        c) Make = 7,200 VA
        d) Break = 720 VA
    2) Color Code
        a) Red: Stop
        b) Green: Start
        c) Orange: Open
        d) Blue: Closed
    3) As manufactured by
        a) Allen Bradley 800T Series.
        b) SquareD Harmony 9001SK Series.
        c) IDEC TWTD Series.
        d) Cutler Hammer 10250T Series.
        e) Or, Engineer Approved Equal.
    4) Furnish one spare normally open and normally closed contact with each switch.
g. Selector switches
    1) Contacts rated
        a) NEMA A600
        b) 600 VAC maximum
        c) Make = 7,200 VA
        d) Break = 720 VA
    2) As manufactured by
        a) Allen Bradley 800T Series.
        b) SquareD Harmony 9001SK Series.
        c) IDEC CS Series.
        d) Cutler Hammer 10250T Series.
        e) Or, Engineer Approved Equal.
    3) Furnish one spare normally open contact and normally closed contact with each switch.
h. Pilot lights
    1) Transformer type pilot lights
    2) 120 VAC
    3) Push-to-Test
    4) Provide indicating light colors as follows:
        a) White: Power On
        b) Green: On / Running
        c) Red: Off
        d) Amber: Abnormal / Alarm Condition / Failure
        e) Blue: Closed

5) As manufactured by
   a) Allen Bradley 800T Series.
   b) SquareD Harmony 9001SK Series.
   c) IDEC TWTD Series.
   d) Cutler Hammer 10250T Series.
   e) Or, Engineer Approved Equal.

2. Control Components Corrosive Areas
   a. All operators, pushbuttons, selector switches, pilot lights are to be of the same manufacturer.
   b. NEMA 4X corrosion resistant.
   c. Exterior parts to be made of high impact strength fiberglass reinforced polyester.
   d. Incorporating an internal neoprene boot which completely encloses all internal parts.
   e. Industrial grade full size 1-3/16" (30mm) diameter.
   f. Pushbutton:
      1) Having an integral wiping gasket around the pushbutton that cleans the wall of the pushbutton guard of any foreign material accumulation as the button is operated.
      2) Contacts rated:
         a) NEMA A600.
         b) 600 VAC maximum.
         c) Make = 7,200 VA.
         d) Break = 720 VA.
      3) Color code:
         a) Red: Stop / Off
         b) Green: Start / On
         c) Orange: Alarm / Failure
         d) Blue: Open
      4) As manufactured by:
         a) Cutler Hammer 10250T Series.
         b) SquareD Harmony 9001SK Series.
         c) Allen Bradley 800H Series.
         d) Or, Engineer Approved Equal.
   g. Selector switches:
      1) Contacts rated:
         a) NEMA A600.
         b) 600 VAC minimum.
         c) Make = 7,200 VA.
         d) Break = 720 VA.
      2) As manufactured by:
         a) Cutler Hammer 10250T Series.
         b) SquareD Harmony 9001SK Series.
         c) Allen Bradley 800H Series.
         d) Or, Engineer Approved Equal.
   h. Pilot lights:
      1) Transformer type pilot lights.
      2) 120 VAC.
      3) Corrosion resistant.

4) Push-to-Test.
5) With LED type lamps
6) Provide indicating light colors as follows:
   a) White: Power On / Normal Condition
   b) Green: On / Running
   c) Red: Off / Stopped
   d) Amber: Abnormal / Alarm Condition / Failure
   e) Blue: Closed
7) As manufactured by:
   a) Cutler Hammer 10250T Series.
   b) SquareD Harmony 9001SK Series.
   c) Allen Bradley 800H Series.
   d) Or, Engineer Approved Equal.

E. Terminal Blocks
1. Field terminal or inter-cabinet wiring blocks.
   a. DIN-Rail Mounted.
   b. Terminal to be screw type.
   c. Recessed terminal hardware to minimize the possibility of contact with current carrying parts.
   d. Molded of high dielectric material.
   e. Minimum rating 600 VAC.
   f. All external connections to and from all control panels must be via terminal blocks including control circuits and solenoid circuits.
   g. All individual terminals and terminal blocks shall be marked in a permanent manner with printed identification.
   h. Grounding Terminals blocks shall be Green/Yellow
   i. As manufactured by:
      1) Allen Bradley
      2) Phoenix Contact.
      3) Wago.
      4) ABB/Entrelec.
      5) Or, Engineer Approved Equal.

F. Conductors Within Control Panel
1. Wire markers:
   a. All conductors within the control panel are to be permanently marked with wire numbers at each end.
   b. Wire numbers are to correspond to the wire numbers on the control drawings and as detailed in Section 26 05 53.
   c. Wire numbers are to correspond to the terminal block number to which they are attached in the control panel.
   d. Markers shall comply with the requirements of Section 26 05 53.

G. Nameplates
1. In conformance and full compliance with Section 26 05 53.
   a. All control components within the control panel shall have engraved laminated plastic nameplates secured with stainless steel screws or epoxy

cemented in place. Nameplates cannot be attached to the covers of the panel channel.

2. All components on the front cover shall be identified by nameplates.
   a. Use standard manufacturer engraved nameplates for all pushbuttons, and selector switches only if color matches that specified for engraved nameplates.
      1) If not then furnish nameplates to match colors as specified in Section 26 05 53.
   b. Use engraved plastic laminated nameplates for all other devices, keyboards, and annunciator LED's.
   c. All control panels shall have an engraved, plastic, laminated nameplate identifying the control panel, voltage, and feeder breaker and panel.
   d. On NEMA 4X enclosures use an epoxy based adhesive to affix nameplates to panel.
3. Shall be provided for instruments, function titles for each group of instruments, and other components mounted on the front of panel.
4. A nameplate shall be provided for each signal transducer, signal converter, signal isolator, each electronic trip, and the like, mounted inside the panel. These shall be descriptive, to define the function and system of such element.
5. Lettering, styles, abbreviations and sizes shall be in conformance with ISA-RP-60.6 (1984) with an intended viewing distance of 3 to 6-feet as shown or as selected by the Engineer.

H. Control Circuit Breakers.
1. Each 120 VAC control circuit, instrument, or loop shall be powered from an individual control circuit breaker or fused terminal block.
2. DIN-Rail mounted using the same DIN-Rail as used for the terminal blocks.
3. Manual ON-OFF Switch
4. Rated 240 VAC.
5. Rated 2000 AIC.
6. Current Ratings as required.
7. Provide complete nameplate identifying each circuit.
   a. In conformance with Section 26 05 53.
8. As manufactured by:
   a. ABB S200 Series.
   b. Siemens 5S Series.
   c. Allen-Bradley 1489/1492 Series.
   d. Schneider Electric Multi 9 Series.
   e. SquareD QYU Series.
   f. Or, Engineer Approved Equal.

I. Fuses
1. Isolate Group of PLC/PAC with fuses as detailed in the Contract Drawings.
2. Isolate Group of PLC/PAC Digital Inputs with fuses as detailed in the Contract Drawings.
3. Isolate all PLC/PAC Analog inputs with fuses as detailed in the Contract Drawings.
4. Coordinate fuse size below internal output protection of the PLC/PAC output cards.
5. Fuses to be terminal block mounted.
   a. With Lighted Fuse Puller.

6. Furnish Nameplate identifying each fuse.
    a. Section 26 05 53.
7. Spare Fuses in conformance with paragraph 1.11 of this Section.
8. As manufactured by:
    a. Allen-Bradley.
    b. ABB/Entrelec.
    c. Phoenix Contact.
    d. Wago.
    e. Or, Engineer Approved Equal.

J. Field/Remote Connections
1. All field/remote connections shall be made via terminal blocks.
2. Furnish an individual terminal block space for each wire.
    a. Two wires on one terminal block shall be not be allowed.
3. Furnish an empty wire channel on the panel adjacent to the field/remote terminal block strip to be used to route the field/remote wires prior to connection to the terminal blocks.
4. Spare terminal blocks in conformance with paragraph 1.11 of this Section.

K. Control Voltage.
1. Control voltage shall be supplied via control circuit breakers in the control panel.
2. Control power shall be sourced from the 120 VAC power within the control panel, unless otherwise noted in the plans.
3. Control voltage shall be supplied via a control circuit in the control panel.

L. Transient / Surge Protection
1. Control Panel Power System Level Protection; if not powered by an internally installed uninterruptable power supply (UPS).
    a. The control system manufacturer shall provide protection against voltage surges for all instrumentation furnished under this contract.
        1) Protection shall protect all instrumentation assemblies, components and board mounted electronic devices from damages in the event of direct hit by lightning onto any power line.
        2) Instrumentation line or disturbances device within the facility.
        3) Voltage surges from other sources.
    b. Provide protection against the full spectrum of voltage transients including the relatively rare high energy transients as well as the much more frequent low energy and high frequency noise.
    c. Provide fill in for short term notches up to 50 microseconds. and ANSI C62.41 Category A attenuation.
    d. Provide normal mode noise protection (noise between current carrying conductors).
    e. Shall consist of a system that includes transient voltage surge suppression and an active tracking filter.
    f. Meeting the following requirements:
        1) Response time:
            a) Normal Mode - Less than 1 nanosecond.
            b) Common Mode - Less than 5 nanoseconds.
        2) Safety approvals:

a) UL 1233 (EMI/RFI Filter).
b) UL 1449.

3) Mean-time between failures:
a) Greater than 100,000 hours.

4) Frequency response EMI/RFI small signal RFI or large signal transients.

5) Surge energy capacity:
a) 120 VAC: Line-Neutral, Line-Ground, Neutral-Ground = 160 Joules, Total 480 Joules.
b) 240 VAC: Line 1 - Line 2, Line 1 - Ground, Line 2 - Ground = 280 Joules. Total 340 Joules.

6) Peak surge current capacity (8 x 20 μsec):
a) 6,500 Amperes.
b) 39,900 Amperes total.

g. As manufactured by:
1) Accuvar by Control Concepts a subsidiary of Liebert Corporation.
2) ASCO Model 252 (formerly Liebert Emerson/Edco HSP121BT01RU).
3) Schneider Electric Surgelogic LC/XR/XW Series.
4) Thomas&Betts Joslyn TransEnd Series.
5) Or, Engineer Approved Equal.

2. Data and Signal Line Protectors to be used on each and every signal line:
a. Provide electronic circuits and components from damaging surge voltages and currents.
b. Provide protection of signal and data lines associated with computer, data communications, instrumentation, broadcasting, and industrial control interfaces.
c. Shall be used directly with EIA standard interfaces:
1) RS-485.
2) Modbus/ModbusTCP
3) 4-20 mA instrumentation loops.
4) ProfiNet
d. Repeatedly provide protection against surge currents in excess of 10,000 Amps.
e. DIN-Rail mounted.
f. Cable shields shall be passed through and may be either grounded or not grounded at the protector.
g. System:
1) Heavy duty multi-staged protectors.
2) Solid state stage intercepts the leading edge of the surge with sub-nanosecond response time.
3) Within micro-seconds, a 3-pole common chambered gas tube capable of handling 20,000 ampere lightning current operates and crowbars the surge to ground.
4) The protector remains in the crowbar state until the surge has passed and line voltages return to safe levels.
h. Location:
1) Place at each end of a signal line, data line, or current loop.
2) In the case of daisy chain configuration, such as RS-485, protectors shall be placed at each node.

i. Electrical Characteristics:
1) Surge Life:
a) Greater than 1000 operations with 200 Amps, 10 x 1000 µsec.
b) Greater than 10 operations with 10,000 Amps, 8 x 20 µsec.
2) Leakage current at rate line to ground voltage < 10 µAmps.
3) Signal/Data attenuation at maximum data rate 3 db with 600 Ω terminations
4) Operating temperature -40°F – +140°F (-40°C – +60°C).
j. As manufactured by:
1) Joslyn:
a) For differential signals, such as RS-422 or RS-485, and current loops - Model 1820.
b) For high frequency differential signals and current loops - Model 1821.
c) For line to ground protection, two separate circuits, and ground referenced signals (RS-232) and 4-20 mA loops where the return wire is grounded at the protector - Model 1810.
2) Interlink BT
a) For Profibus
3) Pepperl+Fuchs
a) For Profibus
3. Protection from inductive spikes within the control panel.
a. Provide surge protection across all inductive coils for control relays, starters, solenoids, etc., as noted.

M. Maintenance Bypass Switch:
1. An external maintenance bypass switch shall be installed in the control panel to provide isolation of the UPS from the power line and loads for maintenance purposes
2. Shall be of the make before break design or have a sufficiently short transfer time so that the UPS can be isolated from the critical loads by placing these loads on commercial power without interruption of operation.
3. This applies to both forward and back transfer of the switch.
4. Shall be rated to carry the full input current of the UPS.
5. Manufacturers:
a. Liebert Micro POD.
b. Or, Engineer Approved Equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

3.2 INSTALLATION

A. Control panel installation shall be provided in accordance with the applicable requirements of Section 40 61 00, "Process Control and Instrumentation Systems General.", and the requirements of Division 26.

3.3 FIELD QUALITY CONTROL

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

3.4 CLEANING

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

3.5 DEMONSTRATION

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems General."

3.6 SCHEDULES

A. All control panel testing shall be performed prior to shipping.

B. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems."

3.7 TRAINING

A. In accordance with Section 40 61 00, "Process Control and Instrumentation Systems."

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DIVISION 41
MATERIAL PROCESS HANDLING EQUIPMENT

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SECTION 41 22 00
HOIST AND CRANES, GENERAL

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide the hoisting equipment, ancillary steel, and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of this Section apply to all hoists and cranes unless indicated otherwise.

1.2 REFERENCE STANDARDS

A. Commercial Standards

AISC	Specifications for the Design, Fabrication, and Erection of Structural Steel for Building
AGMA	American Gear Manufacturer's Association
ANSI B30.11	Overhead and Gantry Cranes
ANSI MH 27.1	Underhung Crane and Monorail Systems
ASTM A 36	Carbon Structural Steel
CMA	Crane Manufacturer's Association of America
NEMA	National Electrical Manufacturer's Association

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 20 – Contractor Submittals.

B. Shop Drawings shall include all electrical requirements, weights, wheel loads, dimensions, and clearances required.

C. Technical Manuals: Include complete operating and maintenance instructions of the hoist and crane systems.

1.4 QUALITY ASSURANCE

A. Inspection and Testing Requirements: After erection, the Contractor shall inspect and test all hoists and crane systems in the presence of the manufacturer's service representative, for proper operation and conformance to the Specifications.

B. Acceptance Criteria and Tolerances: The Engineer reserves the right to reject any equipment not conforming to the tolerances, deflections, and lateral stiffness indicated.

1.5 MANUFACTURER'S SERVICES

A. The Contractor shall have the hoist or crane manufacturer furnish the services of a trained, qualified representative for at least one day after the units are installed, for the purpose of inspecting the installation and instructing the Owner's operating personnel.

PART 2 - PRODUCTS

2.1 GENERAL

A. Equipment of similar design shall be from the same manufacturer.

B. The load capacity of each hoist and trolley shall be permanently marked in a conspicuous manner on the equipment. The wire rope reeving shall be configured to sufficiently provide a true, vertical lift with an adequate factor of safety against overloading.

C. All hooks shall be safety type with latch.

D. Motors: Motors shall comply with the requirements of Section 26 20 00 – Low Voltage AC Induction Motors.

E. The Contractor shall verify all dimensions and clearances in the field prior to erection and shall be responsible for the proper fitting and operation of the equipment.

2.2 BASIC MATERIALS

A. Materials used must be new and of the best commercial grade. Where materials are not indicated, the Contractor shall have the manufacturer use the most suitable selection for the given application and environment.

2.3 PLANT FABRICATED ITEMS

A. Fabrication, assembly, and welding shall be carried out by factory-trained specialists and certified welders.

2.4 TOOLS AND SPARE PARTS

A. Tools: The Contractor shall supply one complete set of special wrenches or other special tools necessary for the assembly, adjustment, and dismantling of the equipment. All tools shall be of best quality and furnished in labeled tool boxes of suitable design.

B. Spare Parts: Furnish spare parts as required by the hoist or crane section. Parts shall be properly labeled and identified with the name and number of the equipment to which they belong.

PART 3 - – EXECUTION

3.1 INSTALLATION

A. Hoist and crane equipment shall be installed in strict accordance with the manufacturer's printed instructions.

B. Workmanship shall be in accordance with the referenced standards and codes.

C. Care shall be taken that the structural integrity of beams, columns, walls, floors, and roofs will be maintained at all times.

3.2 USE OF HOISTS AND CRANES BY CONTRACTOR

A. Hoists and cranes shall only be used in construction work if specifically allowed through written request of the Owner. If such use is permitted, the Contractor shall be responsible for obtaining any and all permits or certifications for hoist and crane operation. The Contractor shall also be responsible for maintaining hoist and crane equipment in new conditions, and shall promptly repair any damage or wear to the Owner’s satisfaction.

3.3 FIELD TESTING

A. After completion of the Work, the Contractor shall test all hoist and crane equipment in the presence of the manufacturer's field representative, who shall certify in writing that the equipment meets applicable standards and specifications.

B. The Contractor shall have the hoist or crane manufacturer furnish the services of a trained, qualified representative for at least one day after the units are installed, for the purpose of inspecting the installation and instructing the Owner’s operating personnel.

C. Testing shall be in accordance with CMAA and OSHA requirements.

3.4 PROTECTIVE COATINGS

A. Coat per Section 09 90 00 – Painting and Coating.

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SECTION 41 22 13
BRIDGE CRANES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide electrically-operated bridge crane system(s) complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 01 81 10 – Seismic Design Criteria, Section 11 00 00 - Equipment General and Section 41 22 00 – Hoists and Cranes, General provisions apply to the WORK of this Section.

C. Contractor shall field verify all dimensions in the field prior to fabrication of the bridge crane or any components.

1.2 CONTRACTOR SUBMITTALS

A. Furnish shop drawings and technical manuals per Section 01 33 20 – Contractor Submittals and Section 41 22 00 – Cranes & Hoists, General.

B. Design Calculations: The Contractor shall submit complete design calculations for the crane, runway beams, rails, end stops and other appurtenances that conform to this specification and to the following:
   1. Appropriate portions of the IBC and the AISC Manual of Steel Construction.
   2. Paragraph "Design Criteria" of this Specification.
   3. Seismic: Cranes including runway beams, rails and end stops shall be designed to meet the seismic design as specified in Section 01 81 10 – Seismic Design Criteria, Section 11 00 00 – Equipment General Provisions and the IBC-2018 Standards when the crane is fully loaded.
   4. Design calculations shall be stamped by a licensed professional engineer in the state of Utah. Design calculations shall show sufficient information to allow the Engineer to review conformance with the Specifications.

1.3 QUALITY ASSURANCE

A. Testing and acceptance criteria shall be required as outlined in Section 41 22 00 – Cranes & Hoists, General.

B. Warranty. The manufacturer shall provide standard two year warranty with each bridge crane supplied to this project.

PART 2 - PRODUCTS

2.1 GENERAL

A. The bridge crane system(s) shall be of low headroom type, equipped for electronic lift and travel in both directions and shall be mounted on either standard hot rolled shapes or specially fabricated steel sections per AISC standards. The bridge deflection shall be not exceed 1/800 of the bridge span or no greater than 1 ¼", whichever is less.

B. Overhead bridge cranes shall be the product of a sole manufacturer and shall comply with all Crane Manufacturer's Association of America (CMAA) standards.

C. The runway rails shall be a standard hot rolled shape as per AISC standards, or specially fabricated steel sections, firmly anchored to the structure in accordance with AISC design manual recommendations. The maximum deflection shall not exceed 1/800 of the span, or 1-1/4 inches, whichever is less. The completed crane system(s) shall be the product of one crane manufacturer regularly engaged in the manufacture of such equipment.

2.2 DESIGN CRITERIA

A. Site Conditions

Equipment Number	Location	Atmosphere
CR-1800	WTP Building, Pump Room	Indoors

B. The bridge crane system shall have the following capacities and dimensions:

Equipment No.	Crane Type	Bridge Type	Capacity, Ton	Controller Type
CR-1800	Top Running	Single Girder	3	Pendent

Equipment No.	Max Hoist Speed, fpm	Max Trolley Speed, fpm	Max Bridge Speed, fpm	Max Trolley Motor, hp	Max Bridge Motor, hp(Qty)
CR-1800	20	65	80	7.5	1(2)

Equipment No.	Crane Height	Girder Length	Min Lift, ft
CR-1800	22'-0"	37'-0"	18'-4"

2.3 FABRICATION

A. Power: Bridge Crane shall be designed to accommodate a 480V-3ph-60Hz power supply. The power supply shall be from enclosed, UL-approved conductor bar systems.

B. Hook and Wire Rope: The lifting hook shall be of drop-forged, heat-treated steel with a 360 degree swivel on a shielded roller thrust bearing with safety spring latch. The wire ropes shall be improved plow steel with steel center complete with swaged fittings.

C. Hoist and Drive: The hoisting drum shall be a large diameter, deep-grooved and flanged drum with at least 2 full turns of rope to remain on the drum at the lowest hook position, with heavy-duty, pre-lubricated sealed bearings. The hoisting controls shall be 2-speed magnetic type. The drum shall be driven by a helical gear reducer with external spur drum gear enclosed in an oil-tight housing. The housing motor shall be a standard, 30 minute duty-motor, 1750 rpm, with suitable NEMA type shaft extension. The hoisting mechanism shall be provided with dc magnet-actuated disc motor brake with hook drift. The motor shall be rated with minimum of 150 percent of full load torque, with gravity type upper and lower hook limit switch and an overload cut off switch to interrupt the raising circuit.

D. Trolley Assembly: The trolley assembly shall be situated to avoid conflicts with head room and hook heights as shown in the drawings and framed by a structural shape welded into a stable assembly for proper wheel and bearing alignment. The trolley assembly shall be supported by trolley wheels of tread surfaces hardened to a minimum of 300 Brinell. The tread shall be tapered to provide suitable running alignment for trolley. Each wheel shall be supported on tapered roller bearings suitable to take radial and thrust loads. The wheel mounting shall be designed so that axles and wheels can be removed without disturbing other truck elements of their alignment. The wheel tread shall be smooth, true, and uniform within 0.010-inch tread diameter on all wheels.

E. The trolley shall be driven by a 30 minute-duty cycle rated motor, through an oil-tight gear reducer conforming to NEMA specifications. The motor shall be provided with cushion start and controller for smooth travel and load control. The driver shall provide synchronous drive from gear reducer to both drive wheels. The trolley drive shall be provided with integrally mounted spring set and an electrically-released drag brake.

F. Crane Bridge Assembly: The crane bridge assembly shall be a single beam top-riding, electrically driven, dual motor type. The bridge beam shall be designed in accordance with the latest specifications of the Crane Manufacturers Association of America. It shall be fabricated of standard structural shape per AISC Specifications. At full load, the beam shall be designed to limit the deflection to 1/600 of the span, but not to exceed 1-1/4-inch maximum deflection. Provision shall be made to prevent creeping of bridge rails by means of positive stops at the ends of the rails. Crane shall be reinforced with outrigger s to provide squareness with end trucks, adequate lateral stiffness with a minimum lateral moment of inertia of 1/20 that of the vertical beam moment of inertia. Outriggers shall furnish support for squaring shaft and the crane drive motor and gear reducer assembly.

G. End Trucks: The end trucks shall be traversed by stable assembly of structural shapes welded together to provide proper wheel and bearing alignment. The end truck wheel base shall be a minimum of 1/7 of the crane span. One wheel of each end truck shall be driven with rotating axles. The crane and trucks shall be constructed to maintain alignment and distribute truck loads on inner and outer truck members. Each truck shall be designed such that, in the event of a wheel axle or wheel failure, the drop of the load will be no greater than one-inch. The end trucks shall be fastened to the bridge beams with bolts to ensure proper alignment during assembly.

H. Crane Wheels: Crane wheels shall be box type and have tread surfaces hardened to a minimum of 300 Brinell. Treads shall be tapered to provide suitable running alignment for crane. Each wheel shall be supported on tapered roller bearings mounted on stationary axles,

suitable to take radial and thrust loads. The wheels shall be lubricated at the factory and provided with a suitable reservoir of lubricant to eliminate the need for field lubrication. Wheel mounting shall be designed so that axles and wheels can be removed without disturbing other truck elements of their alignment. Wheel treads shall be smooth, true, and uniform within 0.01-inch tread diameter on all wheels.

I. Crane Drive: The crane drive motor shall be totally enclosed, 30 minute cycle rated. The motor shall be integral with a fully enclosed oil splash lubricated gear reduction. The motor, the drive shaft, and the gear reduction shafts shall be supported by permanently lubricated precision ball or roller bearings. The drive shaft shall provide synchronous drive from the gear reduction to both end trucks. The crane drive shall include integrally-mounted spring set electrically-released dc rectified disc brake.

J. Drive Shaft: The drive shaft of the crane shall be supported on lubricated, precision, ball-bearing pillow blocks based on 10-ft maximum centers. These pillow blocks shall be lubricated through pressure grease fittings. The crane drive shaft shall be steel and designed to limit torsional shaft stress to 6,000 psi. Maximum torsional twist angle in the drive shaft shall not exceed one degree of the wheel rotation under maximum rated load, regardless of load location.

K. Bearing Life: Bearings in the crane wheels, those supporting the drive shafts, and the gear reduction shafts, shall be designed for 5,000 hrs L-10 bearing life minimum.

L. Gearing: Gears shall be cut from solid blanks with 20-degree pressure angle involute shape for high strength and shall comply with AGMA specifications for load ratings. All gears operating at higher than 20 fpm pitch line speed shall be fully enclosed in oil-tight housings and lubricated by splash principle.

M. Bridge Stops: Each bridge shall be provided with bumpers capable of stopping the crane (not including the lifted load) at a rate of deceleration not to exceed 3 fps when traveling in either direction at 20 percent of rated speed. The bumpers shall have sufficient energy absorbing capacity to stop the crane when traveling at a speed of at least 40 percent of the rated load speed. Bridge trucks shall be equipped with sweeps which extend below the top of the rail and project in front of the crane wheel.

N. Runway Beams and Rails: The runway beams and rails shall be provided as indicated. The rails shall be an ASCE type securely fastened into the runway beams. The runway beams shall be designed from an ASTM A992 structural steel shape and shall have a maximum deflection not to exceed 1/800 of the span. Necessary column supports or clamps, hanger rods, bolts, and fittings shall be provided as required to meet the requirements of this section and the drawings.

2.4 ELECTRICAL CONTROLS

A. Electrical controls shall be two-speed as required for each equipment specified. Bridge control shall include a mainline magnetic contactor, manually-operated fused mainline disconnect with lock-out provisions, branch circuit fuses, reversing bridge control, and transformer with fused secondary. Bridge control shall be as specified.

1. All bridge cranes specified with a radio control unit shall be supplied with a back-up wall mounted controller located and installed such that it does not interfere with normal crane operations and the entire operation of the crane can be monitored from its location. Motors shall be provided with cushion start.
2. All bridge cranes specified with a pendant controller shall be equipped with a steel cable support. Each pendant shall be installed to be operated at 4 ft above operating floor.

B. Electrical power and controls shall be in accordance with Division 26 of the specifications.

C. Conductor and Wiring: The runway shall be provided with enclosed conductor base electrification adequately supported as recommended by the manufacturer. The bridge shall have a rigid truck festoon type electrification. All other wiring of the crane shall be in rigid or flexible conduit and in accordance with National Electrical Code and complying with Fire Underwriters specifications. When a crane is shipped knocked down, the wiring shall terminate in approved terminal boxes and the wire end shall be provided with permanent marking tags.

D. All controllers, both for the pendant and wall mounted (where required) shall be equipped with 2 pushbuttons for hoisting (one for each direction) and 4 pushbuttons for bridge operation (one for each direction).

2.5 SPARE PARTS

A. The following shall be provided with each overhead bridge crane:
1. One complete set of fuses;
2. One hoist brake disc assembly;
3. One hook latch kit.

2.6 MANUFACTURERS, OR EQUAL

A. The following manufacturers, or equal, are acceptable:
1. American Equipment
2. HOJ Engineering & Sales Co., Inc.
3. Over Head Crane
4. R&M Material Handling

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Bridge crane equipment shall be installed in strict conformance with the manufacturer's published or written instructions. Cranes shall be factory assembled and given a no-load test. Major components of the system shall be marked at the factory to assure prompt and correct field identification.

3.2 FIELD TESTING

A. After complete installation of the system, the bridge crane equipment shall be tested with a load 25 percent above the rated capacity. Testing shall be performed in the presence of an authorized representative of the crane system manufacturer, and in the presence of OSHA certifier, Engineer and Owner.

B. Load and slings shall be provided and removed when the tests are completed.

C. Furnish the labor required to test the crane system. The equipment system shall be operated through a complete lift and lowering cycle, and through complete travel of the trolley, to determine that the equipment will perform the functions of hoisting, braking, and traveling quietly, smoothly, and safely.

D. In the event the equipment fails to meet the above test, make necessary changes and retest the equipment. If the equipment remains unable to meet the test requirements, it shall be removed and replaced with satisfactory equipment at the expense of the Contractor.

E. Correct all defects recorded during the above field tests.

F. No crane equipment shall be used to handle any equipment until the load testing is completed and an OSHA certificate has been provided.

3.3 USE OF CRANE SYSTEM

A. The contractor may use the overhead bridge cranes only in accordance with requirements of Section 41 22 00 – Hoists & Cranes, General.

3.4 PROTECTIVE COATINGS

A. Upon completion of the installation, the Contractor shall verify the bridge beam, runway beams, tracks, hoist and trolley system is painted in accordance with Section 09 90 01 – Protective Coatings. Do not paint the running surfaces of the track.

3.5 SERVICES OF MANUFACTURER

A. Inspection, Startup, and Field Adjustment: An approved representative of the manufacturer shall be present at the Site for 2 days, to furnish the services required by Section 11 00 00 – Equipment General Provisions.

B. Instruction of Owner's Personnel: A training representative of the manufacturer shall be present at the Site for 1 day to furnish the services required by Section 11 00 00 – Equipment General Provisions.

C. For the purposes of this section, a Day is defined as an eight (8) hour period at the Site, excluding travel time. All onsite work hours shall be coordinated with the OWNER and/or Contractor.

D. The Engineer may require that the inspection, startup, owner instruction and field adjustment services above be furnished in two separate trips.

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DIVISION 43
GAS, LIQUID, AND STORAGE

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SECTION 43 20 10
PUMPS, GENERAL

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide all pumps and pumping appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated in the Contract Documents.

C. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the Work and for coordination of design, assembly, testing, and installation of the Work of each pump Section; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each pump Section. Unless otherwise indicated, the single Manufacturer shall be the Manufacturer of the pump.

D. Single Manufacturer: Where two or more pump systems of the same type or size are required, the pumps shall all be produced by the same Manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be furnished in accordance with Section 01 33 20 - Contractor Submittals.

B. Shop Drawings: Shop drawings shall contain the following information:
   1. Pump name, identification number, and specification Section number.
   2. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump. The equipment Manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions. A family of performance curves at intervals of 100 rpm from minimum speed to maximum speed shall be provided for each centrifugal pump equipped with a variable frequency drive.
   3. The Contractor shall require the Manufacturer to indicate on the performance curves the limits recommended for stable operation without surge, without cavitation, and without vibration (except vibration within specified allowable limits). The stable operating range shall be as wide as possible based on actual hydraulic and mechanical measurements taken during the factory performance tests of the pumps.
   4. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.
   5. Data, in accordance with Section 26 20 00 - Low-Voltage Induction Motors, for the electric motor proposed for each pump.
   6. Elevation of proposed Local Control Panel showing panel-mounted devices, details of enclosure type, single line diagram of power distribution, and current draw of panel,

and list of all terminals required to receive inputs or to transmit outputs from the Local Control Panel.

7. Wiring diagram of field connections with identification of terminations between Local Control Panels, junction terminal boxes, and equipment items.
8. Complete electrical schematic diagram.

C. Operation and Maintenance Manual: The Manual shall contain the required information for each pump Section.

D. Spare Parts List: A Spare Parts List shall contain the required information for each pump Section.

E. Factory Test Data: Signed, dated, and certified factory test data for each pump system which requires factory testing, submitted before shipment of equipment.

F. Certifications
1. Manufacturer's certification of proper installation.
2. Contractor's certification of satisfactory field testing.

1.3 QUALITY ASSURANCE

A. Factory Testing: The following tests shall be conducted on each indicated pump system:
1. Motors: All motors of sizes 100 hp and larger shall be assembled, tested, and certified at the motor factory and the working clearances checked to insure that all parts are properly fitted. The tests shall be in accordance with ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators, and ANSI/IEEE 115 - Test Procedure for Synchronous Machines, including heat run and efficiency tests. All computations shall be recorded and certified and dated copies of the test results shall be furnished.
2. Pump Systems: All centrifugal pump systems 100 hp and larger shall be tested at the pump factory in accordance with the Test Code for Centrifugal Pumps of the Standards of the Hydraulic Institute, Inc., Perform Acceptance Test Grade 1B. Tests shall be performed using the complete pump system to be furnished, and a test motor.
3. For motors smaller than 100 hp, the Manufacturer's certified test motor shall be acceptable. Testing of prototype models will not be acceptable. The following minimum test data shall be submitted:
    a. Hydrostatic test data
    b. A minimum of five hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, recorded on data sheets as defined by the Hydraulic Institute.
    c. Pump curves showing head, flow, bhp, efficiency, and NPSH requirements.
    d. Certification that the pump horsepower demand did not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve.
4. Factory Witnessed Tests: Witness tests are not required.

B. Warranty: Unless otherwise specified, each pump shall be supplied with manufacturer’s standard warranty of one (1) year from substantial completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. Compliance with the requirements of the individual pump Sections may necessitate modifications to the Manufacturer's standard equipment.

B. Performance Curves: All centrifugal pumps shall have a continuously rising curve. In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor or engine, or encroach on the service factor.

C. No cavitation shall be allowed in pumps operating within the stable operating range for the specified operating conditions. For the purposes of this provision, cavitation shall be recognized and accepted as being present in a pumping unit if cavitation noise can be perceived either by the human ear or by acoustic instruments or devices. The presence or absence of cavitation noise shall be verified by the Owner during both the factory performance tests of the pumps and during operation of the pumps up to the end of the warranty period. To assist in revealing potential cavitation during the factory performance tests, in addition to all other required tests, the Manufacturer shall force the pumps to operate at the specified minimum net positive suction head available for each of the following conditions: minimum flow rate, design flow rate and head, and maximum flow rate.

D. All components of each pump system provided under the pump Sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors, variable frequency controls if required, necessary mountings, and appurtenances.

2.2 MATERIALS OF CONSTRUCTION

A. All materials shall be suitable for the intended application; materials not specified shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

1. Cast iron pump casings and bowls shall be of austenitic ductile iron, conforming to ASTM A 439 - Specification for Austenitic Ductile Iron Castings, or equal.
2. Bronze pump impellers shall conform to ASTM B 62 - Specification for Composition Bronze or Ounce Metal Castings, or B 584 - Specification for Copper Alloy Sand Castings for General Applications, where dezincification does not exist.
3. Stainless steel pump shafts shall be Type 416 or 316. Miscellaneous stainless steel parts shall be of Type 316.
4. All anchor bolts, nuts, and washers that are not buried or submerged shall be hot-dip galvanized, unless otherwise specified in individual pump Sections. Buried or submerged bolts, nuts, and washers shall be stainless steel in accordance with Section 05 50 00 – Metal Fabrications.

2.3 PUMP COMPONENTS

A. Flanges: Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 or B16.5 - Pipe Flanges and Flanged Fittings Dimensions.

B. Lubrication: Vertical pump shafts of clean water pumps shall be product water-lubricated, unless otherwise specified. Deep-well pumps and pumps with dry barrels shall have water- or oil-lubricated bearings and seals and enclosed line shafts. Pumps for other process fluids shall be lubricated as indicated.

C. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

D. Vortex Suppressors: Vertical pumps with marginal submergence shall be provided with vortex suppressors.

E. Drains: All gland seals, air valves, cooling water drains, and drains from variable frequency drive equipment shall be piped to the nearest floor sink, or drain, with galvanized steel pipe or copper tube, properly supported with brackets.

F. Grease Lubrication: For all vertical propeller, mixed-flow, and turbine pumps, other than deep well pumps, of bowl sizes 10-inches and larger, the Contractor shall provide a stainless steel tube attached to the column for grease lubrication of the bottom bearing.

G. Stuffing Boxes: Where stuffing boxes are indicated for the pump seal, they shall be of the best quality, using the Manufacturer's suggested materials best suited for the specific application. For drainage and liquids containing sediments, the seals shall be fresh-water flushed, using lantern rings.

1. Unless otherwise specified, the packing material shall be interlaced Teflon braiding, containing 50 percent ultrafine graphite impregnation to satisfy the following:
   a. Shaft speeds - up to 2500 rpm
   b. Temperature - up to 500 degrees F
   c. pH range - 0 to 14.
2. If fresh water is not available, the seal shall be flushed with product water cleaned by a solids separator as manufactured by John Crane Co., Lakos (Claude Laval Corp.), or equal.

H. Mechanical Seals: Mechanical seals shall be fresh water-flushed unless indicated otherwise; in which case product water cleaned by a solids separator as above shall be used. Mechanical seals shall be as manufactured by the following, or equal:

Type	Manufacturer
Wastewater Pumps	Double seals: John Crane Type L Double; Borg-Warner Type L Double; Chesterton
Abrasives, Grit, or Lime Slurry Pumps	Double seals: John Crane Type I (hard faces); Borg-Warner Type L (hard faces); Chesterton
Chemicals or Corrosive Liquid Pumps	Single seals: John Crane Type 8-1, 9; Borg-Warner Type Q, QB; Chesterton

Water Pumps Hot and Cold	Single seals: John Crane, Type I, 21; Borg-Warner Type L; Chesterton

I. Where indicated, a buffer fluid must be circulated a minimum 20 psi above discharge pressure, or as required by the Manufacturer, in order to maintain reliable seal performance.

J. Mechanical seals for all services other than chemicals and corrosives shall be equipped with non-clogging, single coil springs and non-sliding, internal, secondary elastomers. Metal parts shall be Type 316 stainless steel, Alloy 20, or Hastelloy B or C.

2.4 PUMP APPURTENANCES

A. Nameplates: Each pump shall be equipped with a stainless steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed, and Manufacturer's name and model number. Dimension and flow information shall be in metric units, followed by English units in parentheses.

B. Solenoid Valves: The pump Manufacturer shall provide solenoid valves on the water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical ratings shall be compatible with the motor control voltage.

C. Gauges: all pumps (except sample pumps, sump pumps, and hot water circulating pumps) shall be equipped with pressure gauges installed at pump discharge lines. Pump suction lines shall be provided with compound gauges. Gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.
   1. Where subject to shock or vibrations, the gauges shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.
   2. Pressure and compound gauges shall be provided in accordance with Section 17205 – Pressure Gauges.

PART 3 - EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Inspection, Startup, and Field Adjustment: Where required by the individual pump Sections, an authorized service representative of the Manufacturer shall visit the site for the number of days indicated in those Sections to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.
   1. Installation of the equipment.
   2. Inspection, checking, and adjusting the equipment.
   3. Startup and field testing for proper operation.
   4. Performing field adjustments to ensure that the equipment installation and operation comply with the specified requirements.

B. Instruction of the Owner’s Personnel

1. Where required by the individual pump Sections, an authorized training representative of the Manufacturer shall visit the site for the number of days indicated in those Sections to instruct the Owner's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.
2. The representative shall have at least two years' experience in training. A resume for the representative shall be submitted.
3. Training shall be scheduled a minimum of three weeks in advance of the first session.
4. Proposed training material and a detailed outline of each lesson shall be submitted for review. Comments shall be incorporated into the material.
5. The training materials shall remain with the trainees.
6. The Owner may videotape the training for later use with the Owner personnel.

3.2 INSTALLATION

A. General: Pumping equipment shall be installed in accordance with the Manufacturer's written recommendations.

B. Alignment: All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. Lubricants: The Contractor shall provide the necessary oil and grease for initial operation.

3.3 PROTECTIVE COATING

A. Materials and equipment shall be coated as required in Section 09 90 01 – Protective Coatings.

3.4 FIELD TESTS

A. Where required by the individual pump Sections, each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation, or overheating of bearings.

B. The following field testing shall be conducted:
1. Startup, check, and operate the pump system over its entire speed range. Vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the Engineer.
2. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.
3. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test, unless insufficient liquid volume is available.
4. Electrical and instrumentation tests shall conform to the requirements of the Sections under which that equipment is indicated.

C. Field testing will be witnessed by the Engineer. The Contractor shall furnish 5 days advance notice of field testing.

D. In the event any pumping system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.

E. After each pumping system has satisfied the requirements, the Contractor shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the field tests, a listing of all persons present during the tests, and the test data.

F. The Contractor shall bear all costs of field tests, including related services of the Manufacturer's representative, except for power and water which the Owner will bear. If available, the Owner's operating personnel will provide assistance in field testing.

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SECTION 43 24 03
VERICAL TURBINE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide vertical turbine pumps and drives with associated appurtenances, complete and operable, in accordance with the Contract Documents. All pumps specified herein shall be provided by one manufacturer.

B. The requirements of Section 43 20 10 – Pumps, General apply to this Section.

C. The Supplier shall examine the Site conditions, intended application, and operation of the two pump systems and recommend the pumps that will best satisfy the indicated requirements. Supplier shall review the associated Contract Drawings and confirm its proposed pumps are suited to the installation, configuration and conditions shown.

1.2 CONTRACTOR SUBMITTALS

A. Shop Drawings: Submittals shall be made in accordance with Section 01 33 20 – Contractor Submittals and Section 43 20 10 – Pumps, General.

B. Spare Parts List: The Contractor shall obtain from the manufacturer and submit at the same time as Shop Drawings a list of manufacturer suggested spare parts for each piece of equipment specified. The Contractor shall also furnish the name, address and telephone number for the nearest distributor for each piece of equipment.

C. Operation and Maintenance Manual: Provide technical operation and maintenance manuals in accordance with Section 01 33 20 – Contractor Submittals.

1.3 QUALITY ASSURANCE

A. All pumps shall be factory tested in accordance with Section 43 20 10 – Pumps, General.

B. Provide pump manufacturer's standard one-year warranty which starts upon substantial completion of the project.

PART 2 - PRODUCTS

2.1 GENERAL

A. Pump Identification:

Pump Name	Pump Number	Location
Snowmaking Pump 1	P-3100	Pump Room
Snowmaking Pump 2	P-3200	Pump Room
Snowmaking Pump 3	P-3300	Pump Room

Snowmaking Pump 4	P-3400	Pump Room
Snowmaking Pump 5	P-3500	Pump Room
Snowmaking Pump 6	P-3600	Pump Room
Finished Water Pump 1	P-1021	Pump Room
Finished Water Pump 2	P-1022	Pump Room
Finished Water Pump 3	P-1023	Pump Room

2.2 OPERATING CONDITIONS

A. The Work of this Section shall be suitable for long term operation under the following conditions:

Parameter	Units	Value
Duty		Continuous
Drive	Constant and Variable Speed, See Performance Table	
Ambient environment		Indoors
Ambient temperature	Deg F	35 to 110
Ambient relative humidity	%	20 to 95
Fluid service		See Performance Table
Fluid temperature	Deg F	40 to 75
Fluid pH range		7.4 to 8.4
Fluid specific gravity		1.0
Fluid viscosity - absolute centipoises at 60 deg F		1.14
Project site elevation (see Drawings)	ft., msl	5,846
Minimum water surface in pump barrel or wet well (see Drawings)	ft., msl	Snowmaking: 5,865.9 Finished Water: 5,836.5
Pump Configuration (see Drawings)		Snowmaking: "Canned" Pumps Finished Water: Wet Well Pumps

2.3 PERFORMANCE REQUIREMENTS

A. Each pump shall meet the following minimum performance requirements:

Pump Number	Design Flow (gpm)	Design Flow TDH (ft.)*	Design Flow Min. Pump Eff.	NPSH Req'd. (ft.)	Shutoff Head (ft.)
P-3100	2,000	670	82.7%	17	840
P-3200					
P-3300					
P-3400					
P-3500					
P-3600					
P-1021	1,400	730	81.6%	13	989
P-1022					
P-1023	350	650	79.2%	10	854

*At discharge flange.

B. Each pump shall meet the following minimum performance requirements:

Pump Number	Max. Pump Speed (rpm)	Max. Motor Speed (rpm)	Min. Motor Size (hp)	Drive Speed	Fluid Service
P-3100	1770	1770	450	Variable	Non-Potable Raw Water
P-3200				Variable	
P-3300				Constant	
P-3400				Constant	
P-3500				Constant	
P-3600				Constant	
P-1021	1770	1770	350	Variable	Potable Water
P-1022					
P-1023	1770	1770	100	Variable	

C. Pump Dimensions:

Pump Number	Base Plate to Suction Bell (ft.)*	Min. Col. Dia. (in.)	Min. Disc. Dia. (in.)	Disc. Flg. ANSI (psi)	Min. Shaft Dia. (in.)	Max. Bowl Dia. (in.)
P-3100	11.0 **	10	10	350	1-15/16	14
P-3200						
P-3300						
P-3400						
P-3500						
P-3600						
P-1021	13.5	8	8	350	1-15/16	14
P-1022						
P-1023	14.3	6	6	350	1.25	11

* Final length determined by pump manufacturer. See Drawings.

** Final length of suction barrel or "pump can" for the snowmaking pumps to be determined by pump manufacturer. Generally, the pump assembly and shaft shall be kept as short as possible to reduce depth of excavation.

2.4 MATERIALS OF CONSTRUCTION

A. Each vertical turbine pumps shall conform to the following requirements:

Item	Requirement
Bowls	Cast-iron, lined with 3 coats of NSF epoxy having a total thickness of 20 mils DFT. The exterior surfaces of the bowl units shall be coated with 3 coats of NSF epoxy having a total thickness of 16 mils DFT. Lining and coating in accordance with Section 09 90 00 – Painting and Coating
Impeller	Bronze statically and dynamically balanced
Impeller shaft method of connection	Type 316 stainless steel impeller lock collet
Wear rings	Heat Treated 410 stainless steel
Bowl shaft	Stainless steel, Type 410, 416, or 316

Suction bell	Cast iron bell, with bottom bearing and streamlined ribs, lining and coating – see bowls
Column	Steel pipe, not less than Schedule 30, NSF epoxy-lined and coated to 16 mils DFT, maximum 10-ft lengths.
Line shaft and couplings	Stainless steel PSQ, Type 17-4 PH or Type 416 in maximum 10-ft lengths, sized for a critical speed of min 20 percent above max operating speed open. Shaft coupling shall be Type 410 stainless steel, threaded or keyed to the shaft.
Shaft lubrication	Product water
Shaft seal	Mechanical seal, split design (Chesterton 442 or equal) Plan 13 recirculation, or cartridge design mechanical seal.
Line shaft bearings	Rubber with bronze integral bearing retainers at each joint for open line shaft
Discharge head	Fabricated steel, reinforced to withstand pipe thrust, epoxy-lined and coated per bowls, with flange, base plate, and minimum 1-1/4-inch, 3000 lb. forged steel half-couplings for air valve, pressure switch, and drain connections.
Motor shaft coupling	Adjustable spacer coupling
Bowl and suction	Product-lubricated bronze sleeves case bearings
Suction Can or Barrel (P3100-P3600)	"Closed bottom can" inlet for pumps. Dimensions and configuration per Drawings and pump manufacturer to meet Hydraulic Institute (HI) standards. Welded fabricated steel pipe, ASTM A53, 0.375" Tw. Base plate shall be coated and pump can lined and coated with 3 coats NSF epoxy, 16 MDFT per bowls.

2.5 ELECTRICAL REQUIREMENTS

A. Drive: All pumps shall be provided with a vertical, solid shaft, high efficiency, high thrust, WP1, 480 volt, 3-phase, 60-Hertz heavy duty, inverter duty (for both variable and constant speed) electric motor in accordance with Section 26 20 00 – Low-Voltage AC Induction Motors. Each electric motor shall be designed to accept the total, unbalanced thrust imposed by the pump. Bearings shall be rated for a minimum L-10 life of 60,000 hours. All motors shall have three winding and two bearing RTDs. Provide anti-reverse ratchets. Space heaters and vibration sensors are not required.

B. All Finished Water Pumps and two Snowmaking Pumps shall be adjustable speed and Contractor shall coordinate supply of variable speed drives in accordance with Section 26 29 23 – Variable Frequency Drives. Pump supplier is not required to provide variable frequency drives.

2.6 CONTROLS & INSTRUMENTATION

A. Pumps shall be controlled in accordance with Division 26 and Division 40.

2.7 SPARE PARTS

A. Furnish the following spare parts for a single pump unit of each type specified:

Item	Number
Mechanical Seal	1
Sets of Gaskets and O-rings	2

2.8 MANUFACTURERS, OR EQUAL:

A. Fairbanks Morse

B. Floway (Basis of design – 14JKH, 14JKL, 11XKL)

C. Flowserve

D. Goulds Pumps, Inc.

E. National Pump LLC

PART 3 - EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Inspection, Startup, and Field Adjustment: The factory authorized service representative (not sales representative) of the manufacturer shall be present at the Site for four (4) full 8-hour working days, to furnish the services required by Section 43 20 10 – Pumps, General.

B. Instruction of Owner's Personnel: The training representative of the manufacturer shall be present at the Site for one (1) full 8-hour work day to furnish the services required by Section 43 20 10 – Pumps, General.

C. For the purposes of this paragraph, a work day is defined as an 8-hour period at the Site, excluding travel time. All on-site work hours shall be coordinated with the Owner and/or General Contractor.

D. The Engineer may require that the inspection, startup, and field adjustment services above be furnished in three (3) separate trips.

END OF SECTION

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SECTION 43 41 43
POLYETHYLENE TANKS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide polyethylene tanks and accessories, complete and in place, in accordance with the Contract Documents.

B. Unit Responsibility: The Contractor shall assign responsibility for furnishing the tank system as indicated except for level indication to the tank manufacturer.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ASTM D 618	Standard Practice for Conditioning Plastics for Testing
ASTM D 638	Tensile Properties of Plastics
ASTM D 746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D 790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D 883	Standard Terminology Relating to Plastics
ASTM D 1505	Standard Test Methods for Density of Plastics by the Density-Gradient Technique
ASTM D 1525	Standard Test Method for Vicat Softening Temperature of Plastics
ASTM D 1693	Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D 1998	Polyethylene Upright Storage Tanks
ASTM D 2765	Standard Test Methods for Determination of Gel Content and Swell Ratio of Cross-linked Ethylene Plastics
ASTM D 2837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
ASTM D 3892	Standard Practice for Packaging/Packing of Plastics

ASTM F 412	Standard Terminology Relating to Plastic Piping Systems
ANSI B 16.5	Pipe Flanges and Flanged Fittings
ARM	Low Temperature Impact Resistance (Falling Dart Test Procedure)
NEMA ICS 6	Enclosures for Industrial Control and Systems

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop Drawing Information
   1. Tank Material
      a. Data sheet
      b. Information showing compatibility with chemical to be stored under the concentration and temperature conditions expected
      c. Color sample
      d. Gasket style and material
      e. Bolting material
   2. Dimensioned tank drawings
      a. Location and orientation of openings, fittings, accessories, instrumentation, and anchors and supports
      b. Details of inlet and outlet fittings, manways, flexible connectors, and vents
   3. Tank pad requirements such as blockouts where a full drain fitting is required.
   4. Calculations stamped and signed by a registered Engineer and certified by the tank manufacturer.
      a. Wall thickness. Hoop stress shall be indicated.
      b. Tank restraint system. Show seismic criteria.

C. Proposed Manufacturer Warranty

D. Manufacturer's Unloading Procedure

E. Manufacturer's Installation Instructions

F. Manufacturer’s Written Certification; signed by a senior company officer stating that the tank design, type, and material is compatible with the indicated chemical to be stored in the tank.

G. Manufacturer’s Qualifications: List of installations documenting manufacturer's qualifications. Include names and telephone numbers for tank installations available for the design Engineer to visit.

H. Technical Manual: Include the following in Part 2 - Operational Procedures:
   1. Manufacturer's recommendations for installation.
   2. Installation and adjustment procedures to include foundation bolt and piping connections to the tank.
   3. Repair procedures for typical situations, including small holes, pinholes, and minor cracks in the tank.

I. Factory Test Report
   1. Tank nominal capacity and diameter, material, hoop stress design
   2. Review audit for wall thickness
   3. Fitting placement
   4. Visual inspection

J. Certification: After inspecting the installed tank, a representative of the manufacturer shall certify in writing that the tank has been installed in accordance with the manufacturer's recommendations. Certification shall be submitted to the Construction Manager.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications
   1. The tank manufacturer shall have a record of at least 10 installations during the previous 5 years for the tank sizes and for the chemicals indicated in this Contract.

1.5 SPECIAL WARRANTY REQUIREMENT

A. The tank shall be warranted for 5 years to be free of defects in material and workmanship.

PART 2 - PRODUCTS

2.1 GENERAL

A. Tanks shall be rotationally-molded high density crosslinked (HDXLPE), one piece seamless construction, cylindrical in cross-section, vertical in axis; complete with piping inlets and outlets, drains, and overflows installed by manufacturer; and anchoring system. Tanks shall be in accordance with ASTM D 1998 unless otherwise indicated. Lined or laminated tanks will not be accepted. Tank outlets shall be either molded on the tank and be the same material or mechanically attached to a chemical compatible insert encapsulated into the tank wall. Covered tanks shall be vented, and where indicated, tanks shall be provided with entrance manways, and level indicators. Tanks shall be marked to identify the manufacturer, date of manufacture, serial number, capacity, and chemical to be stored.

B. Dimensions and tolerances shall be in accordance with ASTM D 1998. Measurements shall be taken with the tank empty, in the vertical position.

2.2 TANKS

A. Service: Chemical storage tanks shall be suitable for the following operating conditions:

Equipment number – Chemical Stored (% and SG)	TNK-1900 – Primary Coagulant PACL (SG:1.37) TNK-1910 – Anionic Polymer Solution (0.25% to 2.0%) TNK-1970 – Caustic Soda (25% SG:1.35) TNK-1980 – 0.8% Sodium Hypochlorite (SG:1.02) TNK-1998 – Salt Brine (SG:1.20) Provided as part of the OSHG System, see Specification 46 33 50
pH range	4 - 14
MAX chemical temp., deg. F	80
MIN chemical temp., deg. F	50
MIN ambient air temp., deg. F	50

B. Materials shall be virgin polyethylene as compounded and certified by the manufacturer, be the type indicated in the tank schedule, and shall meet or exceed the following:

1. Mechanical Properties of HDXLPE Tank Material

Parameter	ASTM Test Method	Value
Density of resin, gm/cc	D 1505	0.938 to 0.944
Tensile strength, psi (2-inches per min)	D 638	2600
Elongation at break, percent (2-inches per min)	D 638	400
ESCR (100 percent lgepal, Condition A, F50), hours	D 1693	1000
ESCR (10 percent lgepal, Condition A, F50), hours	D 1693	greater than 1000
Vicat softening temperature, deg. F	D 1525	248
Flexural modulus, psi	D 790	100,000

2. Resin used in the tank shall be by Exxon Mobil Chemicals**,** or equal, and shall contain ultraviolet stabilizer as recommended by the manufacturer. Where black or white tanks are indicated, the resin shall be compounded black or white.

2.3 TANK CONSTRUCTION

A. The minimum wall thickness of the cylindrical portion at any chemical depth shall be determined by ASTM D 1998 as modified by the following equation. Wall thickness shall be tapered, and no wall shall be less than 0.187-inch thick at the top.

a. $T = 0.433 \times ASG \times OD \times H \times OD/2 \times SF \times SD$

b. Where: T = wall thickness at any depth, in

c. ASG = adjusted specific gravity of chemical (See Note A)

d. H = depth of chemical in tank ft

e. OD = outside diameter of tank, ft

f. SF = service factor based on wall thickness

g. SD = hydrostatic design stress, 600 psi (See Note B)

h. Note A: The specific gravity of the fluid shall be multiplied by 1.5 to obtain the adjusted specific gravity, ASG. The maximum ASG value shall be 1.9.

i. Note B: The hydrostatic design stress shall be derated for temperatures above 100 deg F according to ASTM D 1998.

j. The minimum wall thickness shall be sufficient to support its own weight in an upright position without external support. Flat areas shall be provided for attachment of large fittings on the cylindrical portion.

2. The top head shall be integrally molded with the cylindrical wall. Its minimum thickness shall equal the thickness of the top of the wall. The top head of tanks 2000 gal and larger shall provide a minimum of 1300 square inches of flat surface for pipe nozzle locations.

3. The bottom head shall be integrally molded with the cylindrical wall. Knuckle radius shall be in accordance with ASTM D 1998.

4. Tanks with 2000 gal capacity or larger shall have at least 3 lifting lugs molded into the top head. Lugs shall be designed for lifting an empty tank.

5. Tie-down lugs may be molded into the top head.

6. Manways

a. Unless otherwise indicated, bolted sealed top manway shall be either 18-, 20-, or 24-inches and be in locations easily accessible from the nearest worker access position. The sealed manway shall be constructed of polyethylene material. The bolts shall be compatible with the chemical stored. Gaskets shall be closed cell, cross-linked polyethylene foam and Viton materials.

b. For tank smaller than 500 gallons, provide lid with hinged opening for easy access.

B. Tank Schedule

Equipment No. (Service)	TNK-1900 (PC)	TNK-1910 (PL)	TNK-1970 (CS)	TNK-1980 (SH)	TNK-1998 (Brine)
Configuration (see Note 1)	CD	FLH	CD	CD	As needed*
Material Type	HDPE (cross-link)				*
Insulation	No				
Maximum Nominal Diam, in	90	36-42	64	84	*
Maximum Nominal Sidewall Height, in (see Note 2)	108	50-70	124	104	*
Maximum Overall height, in	120	70	144	120	*
Minimum Nominal capacity, gallons (see Note 5)	2,200	300	1,500	2,500	*
Manway (see Notes 3 and 4) Mounting with Diameter, in	TM 24	NA	TM 24	TM 24	*
Exposure	Indoors				
Color	White				

* Brine tank provided as part of the On-Site Sodium Hypochlorite Generation System (OSHG), see Specification 46 33 50.

1. Note 1: CD = closed, domed top
   a. CF = closed, flat top
   b. OIF = open, internal flange
   c. OEF = open, external flange
   d. FLR = flat lid, removable
   e. FLH = flat lid, hinged
2. Note 2: Nominal height of domed top tanks is the dimension measured along the straight cylindrical portion of the tank and does not include the rounded top.
3. Note 3: TM = top mount
4. Note 4: Unless otherwise noted, manways shall be integrally molded with the tank.
5. Note 5: Nominal volume shall be calculated based on the straight cylindrical sidewall of the tank, or to the invert of overflow, whichever is lower.

C. Fittings

1. Tank fittings for large tanks shall be according to the fitting schedule below and oriented as shown on the drawings in the Contract Documents. Gasket material shall be EPDM. Fittings shall be compatible with the chemical stored, be bolted double flanged fittings, Schedule 80, or threaded bulkhead type. Threaded fittings shall use American Standard Pipe Threads. No metals shall be exposed to tank contents. If tanks are insulated, fittings shall be installed at the factory prior to application of the insulation.
2. Tanks smaller than 500 gallons shall have fittings as recommended by manufacturer.

	Tanks TNK-1900, 1970, 1980 Fitting Type (See Note 4) and Size	
Port Description.	Diam (in)	Type of Fitting
Fill (top mounted)	As indicated in the drawings	TB
Overflow		BF-T
Tank drain (flush with bottom of tank)		IMF
U-Vent (high point of tank)		TB
Outlet to pump (3" above floor)		BF-T
Level indication (top mounted)		BF-T

3. Note 4: Refer to Drawings for fitting size and location. Abbreviations for fittings are:
   a. TB: Threaded bulkhead fitting
   b. BF-H: Bolted flange fitting with Hastelloy-C studs and polyethylene encapsulated heads.
   c. BF-SS: Bolted flange fitting with 316 SS studs and polyethylene encapsulated heads.
   d. BF-T Bolted flange fitting with titanium studs and polyethylene encapsulated heads
   e. DB-SD: Double bolt with siphon drain, 316 SS studs, and polyethylene encapsulated heads.
   f. IMF: Integrally molded flanged.
   g. TST: Threaded siphon tube
   h. SWST: Solvent-welded siphon tube
   i. PVC: Double-nut PVC fitting.
   j. Bulkhead fittings shall be constructed of PVC, PP, or other material compatible with the chemical stored. Gaskets shall be a minimum of 1/4-in thickness and be constructed of 40 to 50 durometer EPDM, 60 to 70 durometer Viton, or material compatible with the chemical in the tank.
4. Bolted flange fittings shall be constructed with two 150 psi flanges, two 150 psi flange gaskets, and the correct number and size of all-thread bolts recommended by the flange manufacturer. Flanges shall be constructed of PVC type 1, grade 1. Gaskets shall be min 1/4-in thick, constructed of 40 to 50 durometer EPDM, 60 to 70 durometer Viton, or material compatible with the chemical in the tank. There shall be minimum 4 full-thread bolts. Bolt heads may be gasket-flanged or may be encapsulated in a type of polyethylene compatible with the chemical stored. If encapsulated, the bolt head shall not contact the fluid in the tank and shall cover the head plus 1/4-in of threads away from the head. Polyethylene shall be color coded to identify the bolt metal underneath. Encapsulated heads shall have a gasket to provide a sealing surface against the inner flange. Bolt holes shall straddle the principal centerline of the tank in accordance with ASME B16.5
5. Integrally Molded Fittings (IMF). These fittings shall be an integral part of the tank and provide complete drainage of liquid through the sidewall of a flat bottom tank. The attachment shall be constructed from a Schedule 80 PVC, stainless steel, or compatible material and be standard at 2-, 3-, 4- or 6-in with inside diameter depending on the tank size.
6. Down Pipes and Fill Pipes: Down pipes and fill pipes shall be supported at 5-ft max intervals with support from standard bulkhead fitting tank attachments or welded PE

supports. Down pipes and fill pipes shall be PVC or material compatible with the chemical stored.

7. U-Vents: Each tank must be vented for the material and flow and withdrawal rates expected. U-vents should comply with OSHA 1910.106(F)(iii)(2)(IV)(9) or shall be as large as the filling or withdrawal connection, whichever is larger. The vent shown above has been sized at 1" larger than the fill line. The vent size shall be confirmed by the tank manufacturer and be furnished complete with insect screen. Vents shall be constructed of PVC or material compatible with the chemical stored.
8. Flange Adapters: Adapters may be used to adapt threaded or socket fitting components to 150 psi flange connections. Adapters shall be of material compatible with the chemical stored.
9. Ladders: Ladders shall be constructed of FRP. Ladders must be designed to OSHA standard 2206; 1910.27. Ladders shall be mounted to the tank in such a way that tank expansion and contraction are not restricted. Top ladder mounts shall be connected to the tank as appropriate.
10. Attachments: Pipe attachments at fittings shall be equipped with flexible couplers or other provisions for movement. Piping attachments shall allow for 3 to 4 percent movement.

2.4 LEVEL INDICATON

A. Primary level indication shall be an ultrasonic type level sensor device, provided and installed by the Contractor as part of the plant instrumentation and control system (see Equipment Schedule in the Drawings). Contractor shall coordinate with the tank manufacturer the flange interface with the level sensor device.

B. See Through Level Indication: Graduations shall be marked on the tank exterior at every 200 gallon interval with 1,000 gallon intervals clearly labeled for bulk storage tanks. See 46 33 00 Chemical Feeding Equipment, General.

2.5 TANK STANDS, SEISMIC, AND WIND RESTRAINT SYSTEM

A. The restraint assembly shall be designed and manufactured for IBC per the factors listed in the Contract Documents. No liquid weight may be used to resist seismic uplifting and overturning where tanks are not anchored.

2.6 SAFETY SIGNS

A. Each tank shall be clearly marked with hazardous material warning signs, 10-inches by 14-inches in size. Each sign shall have the word "DANGER" and the name of the chemical stored, printed in large block letters and mounted directly adjacent to the tank outlet and tank inlet. Each entry manway shall be provided with a sign reading "DANGER--CONFINED SPACE--HAZARDOUS ATMOSPHERE". Signs shall comply with Section 10 14 00 - Signage and the requirements herein.

2.7 FACTORY TESTING

A. Material Testing
1. Low temperature impact test: Condition samples taken from fitting cutouts frozen for 2 hours at minus 40 degrees F. Perform impact tests in accordance with ASTM D

1998. Specimens less than 1/2-in thick shall be tested at 100 ft.-lb. and specimens equal to or thicker than 1/2 -in shall be tested at 200 ft.-lb.

2. Degree of cross-linking (applicable to cross link material only): Use Method C of ASTM D 2765 to determine the ortho-xylene insoluble fraction of cross-linked polyethylene. Samples from the inside of the tank 1/8-in deep shall test at no less than 65 percent.

B. Tank Testing

1. Dimensions: Take exterior dimensions with the tank empty, in the vertical position. Outside diameter tolerance, including out-of-roundness, shall be per ASTM D 1998. Fitting placement tolerance shall be 1/2-in vertical and 2 degrees radial.
2. Visual: Inspect for foreign inclusions, air bubbles, pimples, crazing, cracking, and delamination.
3. Wall Thickness
   a. Tanks 2000 gal or larger shall be measured for wall thickness by ultrasonic methods at 6-in, 1-ft, 2-ft, and 3-ft up the sidewall at zero and 180 degrees around the circumference from the outlet.
   b. Tanks smaller than 2000 gal may be tested during a production run and the results reported as representative of each tank in the run.
4. Hydrostatic test: Following fabrication, the tanks, including inlet and outlet fittings, shall be hydraulically tested with water by filling to the brim for a minimum of 4 hours and inspecting for leaks. Following successful testing, the tank shall be emptied and dried prior to shipment.

C. Signed Affidavit. An affidavit signed by the tank manufacturer shall be furnished indicating that the factory tests have been performed and the indicated requirements have been met.

2.8 MANUFACTURERS, OR EQUAL

A. Poly Processing Company
B. Snyder Industries, Inc.
C. Assmann

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the manufacturer's recommendations.

3.2 FIELD TESTING

A. After installation of tank and connections, the tank shall be water tested by filling the entire tank with water and monitoring the tank and connections for at least 24 hours. Leaks shall be corrected prior to acceptance. Following successful field testing, the tank shall be completely emptied and dried.

END OF SECTION

DIVISION 46
WATER AND WASTEWATER EQUIPMENT

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SECTION 46 33 00
CHEMICAL FEEDING EQUIPMENT, GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide chemical feeding equipment, including tote scales, calibration columns, sight glass, and other appurtenances, complete and operable, in accordance with the Contract Documents.

B. Equipment shall be from manufacturers with several years of experience in the manufacture and assembly of similar products, with a record of successful installations. Such manufacturers shall maintain a well-established, authorized, local service agency with sufficient spare parts and personnel to respond within forty-eight (48) hours to any service calls.

C. The requirements of Section 11 00 00 - Equipment General Provisions apply to the Work of this Section.

D. Unless indicated otherwise, the requirements of this Section apply to all chemical feeding equipment in the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop Drawings: Complete fabrication, assembly, foundation, and installation drawings, together with detailed specifications and data covering materials used, power drive assemblies, parts, devices, pumps, tanks, mixers, supports, panels, and other accessories forming a part of the equipment, plus schematics, diagrams, and panel layouts.

C. Certification: The Contractor shall obtain written certification from each manufacturer, addressed to the Owner, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Specifications and the Drawings, and that the materials are best suited for the chemicals handled.

D. Technical Manuals: Furnish complete operations and maintenance manuals prior to start-up.

E. Spare Parts List: The Contractor shall obtain from the manufacturer a list of suggested spare parts for each piece of equipment subject to wear, such as seals, packing, gaskets, nuts, bolts, washers, wear rings, etc.

F. Maintenance: Printed instructions relating to proper maintenance, including lubrication, and parts lists indicating the various parts by name, number, and diagram where necessary, shall be furnished in duplicate with each unit or set of identical units.

G. Field Procedures: Instructions for field procedures for erection, adjustments, inspection, and testing shall be furnished prior to installation of the equipment.

H. Calibration Graphs: The manufacturer's representative shall prepare a calibration graph from field tests for each chemical feed unit which does not have a rate set device. Graphs shall read in pounds per hour for dry feeders or in gallons per hour for liquid feeders. The graph shall show the rate setter graduation conversion to pounds per hour or gallons per hour throughout the range of the feed unit. Each graph shall be furnished on hard paper and be sealed in clear plastic.

1.3 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Erection and Startup Assistance: Service and instruction assistance by the manufacturer's engineering representative for each equipment unit shall be furnished by the CONTRACTOR during the following period:

B. One day during erection, unless indicated otherwise in the feed equipment section.

C. One day during startup, unless indicated otherwise in the feed equipment section.

D. Instruction of Owner's Personnel: The Contractor shall furnish the services of a factory service representative to instruct the Owner's personnel in the operation and maintenance of the equipment. This service shall consist of a minimum one day's visit to the plant for each type of similar equipment.

1.4 QUALITY ASSURANCE

A. Warranty: After completion, the Contractor shall furnish to the Owner the manufacturer's written guarantees that the equipment will operate with the published efficiencies, heads, criteria, and flow ranges and meet these specifications. The Contractor shall also furnish the manufacturer's warranties as published in its literature.

PART 2 - PRODUCTS

2.1 GENERAL

A. Wherever it is required that a single manufacturer shall be responsible for the compatible and successful operation of the various components of any equipment unit, it shall be understood to mean that the Contractor shall provide only such equipment as the designated manufacturer will certify is suitable for use with its equipment and with the further understanding that this in no way constitutes a waiver of any indicated requirements.

B. Manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products.

C. Where two (2) or more units of the same type or size of equipment are required, such units shall be produced by the same manufacturer.

2.2 MATERIALS

A. Materials employed in the equipment shall be suitable for the intended application; materials not specifically called for shall be high-grade, standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended.

B. The following table lists the most commonly used chemicals for water and wastewater treatment and some of the suitable materials for the construction of chemical feeding equipment. Unless the manufacturer proposes more suitable materials, the table shall be adhered to:

Chemical	Suitable Handling Material
Polymers (Ionic) (Cationic) (Nonionic) (100% solution)	Type 316 stainless steel PVC FRP (suitable grade, verify compatibility with manufacturer) Teflon Polypropylene
Citric Acid (50% Solution)	Hastelloy C PVDF FRP (suitable grade, verify compatibility with manufacturer) Viton Teflon Vinyl Saran Polypropylene
Sodium Hypochlorite (NaOCl) (0.8 to 15 % solution)	Hastelloy C Titanium PVC FRP (suitable grade, verify compatibility with manufacturer) Viton Penton Hypalon Vinyl Saran Polyethylene Tyril Glass

2.3 APPURTENANCES

A. Nameplate: Each piece of equipment shall be provided with a nameplate (of material compatible with chemical), indicating equipment characteristics, capacity, motor horsepower, speed, electrical characteristics, manufacturer, model number, serial number, etc.

B. Solenoid Valves: The equipment manufacturer shall provide solenoid valves, which are part of the chemical feeding unit. The solenoid valve electrical rating shall be compatible with the equipment voltage and valves shall be complete with the necessary conduit and wiring from the control panel to the solenoids. The valve material shall be suitable for the intended service in accordance with the Section 40 05 50 – Miscellaneous Valves.

C. Pressure Gauges: Where indicated on Contract Drawings, chemical transfer and metering pumps and other equipment shall be equipped with pressure gauges with diaphragm seals in accordance with Section 40 73 13 – Pressure Gauges, except that the size of gauges on small metering pumps may be smaller than indicated in that section.

D. Calibration Columns: Provide Calibration Columns as indicated on the Contract Drawings. Each Calibration Column shall be an acrylic tube with PVC heads. The columns shall be calibrated for 30 second sampling periods and shall have the capacity as indicated in the table below, and shall have a maximum height of 30 inches. Each column shall be securely supported at both top and bottom.

E. Sight Flow Sight Glass (labelled FG in drawings): Provide sight flow sight glass as indicated on the Contract Drawings. Each sight flow indicator shall be constructed of a PVC body with 150 # rated flanges. The indicator shall be a flutter type. The flow sight glass shall be manufactured by Jacoby Tarbox style 910-FA-FLTR or Engineer approved equal.

F. Reverse Float Type Sight Gauge: Where indicated on Contract Drawings, chemical storage tanks shall be equipped with a 2-inch PVC float type reverse level sight gauge. The sight gauge shall be manufactured by Poly Processing Co. or equal (stock # 4089 for vertical tanks under 7-feet and stock # 3356 for vertical tanks over 7-feet). An internal Promo type tank pipe support as provided by Poly Processing Co. or equal shall be provided to support the interior tank pipe for all float type sight gauge applications. Calibration tape (stock # 6770) shall also be provided with each unit. The Contractor is responsible to calibrate the tanks and apply the Calibration tape in increments of gallons and over and in increments of 500 gallons for tanks less than 10,000 gallons. Calibration of tanks must be approved by the Engineer.

G. Chemical Tank Discharge Connection Expansion Joints: Provide a custom flexible connection for each chemical tank discharge connection as shown on the contract drawings. The flexible connection shall be manufactured by Harrington Plastics or equal. The flexible connection shall consist of all nonmetallic materials: polypropylene braided overwrap, convoluted PTFE liner, and PVDF flanges. The flexible connection shall be a minimum length of 6-inches and shall allow for minimum horizontal and vertical deflection of 1-inch.

H. Equipment Supports: Chemical feeding equipment and piping shall be firmly supported on concrete equipment pads and anchored down. Supports shall be as shown on the Drawings and in accordance with Sections 40 05 00.

I. Variable Speed Drives: Variable speed drives, drive motors, speed control equipment, and accessories shall be furnished in accordance with Section 26 29 23 - Variable Frequency Drives.

J. Controls: Controls shall be housed in enclosures with NEMA ratings, which comply with the area designations of Section 26 00 00 – Electrical Work, General.

K. Safety Equipment: Where required by Code, chemical unloading, storage, and feeding equipment shall be provided with the necessary safety devices and warning signs, clearly visible. Signage shall be as specified in Section 10 14 00 – Signage.

2.4 TOTE SCALES (NOT USED)

2.5 TOOLS AND SPARE PARTS

A. Tools: Special tools necessary for maintenance and repair of the equipment and one pressure grease gun for each type of grease required for the equipment shall be furnished as a part of the WORK; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts: Furnish spare seals, packing, gaskets, wear rings, and bearings as required by the feed equipment sections.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Chemical feeding equipment shall be installed in accordance with governing safety standards, the Shop Drawings, and as indicated.

B. Alignment: Equipment shall be field tested to verify proper alignment, operation as indicated, and freedom from binding, scraping, vibration, shaft runout, leaks, or other defects. Drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. Lubricants: The Work shall include furnishing the necessary oil and grease for initial lubrication and testing of all equipment.

END OF SECTION

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SECTION 46 33 42
DIAPHRAGM TYPE METERING PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide diaphragm type metering pumps, together with all drives, motors, valves, supports, controls, accessories, and appurtenances necessary for feeding chemical solutions, complete and operable, including inspection, start-up and field adjustment in accordance with Section 46 33 00 – Chemical Feeding Equipment, General and the Contract Documents.

B. Pumps shall be of corrosion-resistant construction and be of a suitable material for the chemicals indicated at maximum temperature of 40^0 C. Each pump shall have a variable-speed drive (PMS motor) or steeper motor, complete with pump base. Controller for the pump is to be integral with the pump. Size and characteristics of the pumps shall be as indicated herein.

C. The chemical feed system pumps shall be completely assembled, mounted, calibrated, tested and delivered to the site as a single floor mounted skid or unit per chemical system, complete with all of the accessories listed in this section and as shown in the drawings. All metering pumps/skids shall be mounted/located as shown on the drawings.

D. The requirements of Section 11 00 00 - Equipment General Provisions and Section 43 20 10 – Pumps, General apply to this Section.

E. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump, which will satisfy the indicated requirements.

1.2 SUBMITTAL PROCEDURES

A. Shop Drawings: Submittals shall be made in accordance with Section 01 33 20 –Submittal Procedures and Section 43 20 10 – Pumps, General.
   1. Performance data sheets showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump;
   2. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.

B. Spare Parts List: The Contractor shall obtain from the manufacturer and submit at the same time as Shop Drawings a list of manufacturer suggested spare parts for each piece of equipment specified. The Contractor shall also furnish the name, address and telephone number for the nearest distributor for each piece of equipment.

C. Operation and Maintenance Manual: Provide technical operation and maintenance manuals in accordance with Section 01 33 20 – Submittal Procedures.

D. Special Tools: provide one (1) set of all special tools required to complete assembly or disassembly of the system components.

1.3 QUALITY ASSURANCE

A. Pump Manufacturer shall issue a certificate of proper installation.

B. The chemical feeding equipment shall be the product of a manufacturer who has designed and manufactured similar equipment and has a record of at least five years of successful operation of this type of process.

C. The drive and pump head warranty shall be two years from date of substantial completion and shall cover the motor and pump head assemblies for manufacturing defects on non-consumable components.

PART 2 - PRODUCTS

2.1 GENERAL

A. Each pumping unit shall be furnished as an integral unit with pump head, motor and all other appurtenances specified and required for proper operation. Each pumping unit shall be self-supporting and shall not require anchoring.

B. Identification:

Pump Name	Equipment Number	Location
Sodium Hypochlorite 1	P-1971	Chemical Area - Chlorine
Sodium Hypochlorite 2	P-1981	Chemical Area - Chlorine
Sodium Hypochlorite 3	P-1991	Chemical Area - Chlorine
Primary Coagulant 1	P-1930	Chemical Area - PACL
Primary Coagulant 2	P-1931	Chemical Area - PACL
Caustic Soda 1	P-1950	Chemical Area – Caustic Soda
Caustic Soda 2	P-1960	Chemical Area – Caustic Soda
Floc-Aid Polymer 1	P-1941	Chemical Area –Polymer
Floc-Aid Polymer 2	P-1942	Chemical Area – Polymer
Floc-Aid Polymer 3	P-1943	Chemical Area – Polymer
Floc-Aid Polymer 4	P-1944	Chemical Area – Polymer

2.2 OPERATING CONDITIONS

A. The work of this section shall be suitable for long term operation under the following conditions:

B.

Parameter	Units	Value
Duty		Continuous
Drive		Variable
Ambient Environment		Indoors
Ambient Temperature	Deg F	40 to 75
Ambient Relative Humidity	%	20 to 100
Fluid Service	%	-Sodium Hypochlorite (0.8 to 12.5 max) -Primary Coagulant (Polyaluminum Chloride) -Caustic Soda (25) -Diluted Anionic Polymer Blend (0.25 – 2.0%)
Fluid Temperature	Deg F	40 to 75
Fluid pH Range		4 - 14
Specific Gravity		1.0 – 1.4
Project Elevation	ft, msl	5,846
Maximum Suction Lift	ft	10

2.3 PERFORMANCE REQUIREMENTS

A. Each pump shall have a control range of 1000:1 for pumps up to 8 gph or 800:1 for pumps up to 52 gph to cover the full range of operations required.

B. Each pump shall satisfy the following minimum performance requirements:

Pump Equipment Number	Design Flow Capacity Range (gph)	Pump Head (psi)	Continuous Operating Pressure (psi)	Service
P-1971	1.0 – 50	58	As Needed	Sodium Hypochlorite
P-1981				
P-1991				
P-1930	0.01 – 12	40	As Needed	Primary Coagulant
P-1931				
P-1950	0.01 – 4.0	60	As Needed	Caustic Soda
P-1960				
P-1941	0.1 – 50	30	As Needed	Diluted Polymer Solution
P-1942				
P-1943				
P-1944				

C. Each pump shall be capable of self-priming when completely dry with a suction lift capability of up to 20 ft of water for 4 gph pump, 12 ft of water for 15 gph pumps and 9 ft of water for 50 gph pumps. The pump shall be capable of running dry without damaging effects to the pump or internal components.

D. Each pump shall be capable of auto deaeration during pump standby to avoid breakdowns due to air-locking.

E. Each pump shall be capable of anti-cavitation mode of ether 50% or 25% maximum flow to handle higher viscosity liquids or larger air bubbles.

F. Each pump dosing chemical of ≧900 cP viscosity must utilize spring-loaded check valves.

2.4 MATERIALS OF CONSTRUCTION

A. Pump Head Construction: The pump head shall be constructed of PVDF materials with FKM gaskets and Ceramic check balls where in components are in direct contact with the chemical of service. The pump head shall include connections for ¼" minimum poly-ethylene tubing for suction and discharge to be connected. Pump check valves shall utilize ceramic check balls suitable for chemical service.

2.5 MOTOR, DRIVE AND CONTROLS

A. The pump motor and drive shall be rated for a continuous operation for 24 hrs at an ambient temperature of 400C.

B. Power supply shall be 120 Volt, 60-Hz, 1 Phase.

C. The pump controller and motor shall be designed, manufactured and supplied by the metering pump manufacturer and shall be integral to the pump housing. Initial calibration of each pump shall be performed manually. Thereafter, the dosage of each metering pump shall be programmed for remote control through the plant PLC. The pump housing shall be enclosed in a NEMA 4X/IP65 rated enclosure. The controls shall come equipped to perform batching operations or timed interval injection and shall include input connections for low level, empty tank and leak detection capabilities.

D. The controller shall have a backlit LCD interface/display. The interface shall provide a selection of metered output to be displayed in Gal/hr. The interface shall have a lock function to protect against unauthorized changes. Pumps shall have an input for 4-20 mA analogue control, an input for dual level control or external start/stop, pulse output (or run status), and alarm output. The drive speed of each metering pump shall vary automatically in response to a 4-20 mA flow signal input from the plant PLC in order to maintain a pre-set dosing rate.

E. Each pump larger than 8 gph shall be supplied with an integrated leak detection sensor. The sensor shall be situated such that any leak within the pump head shall be detected and an alarm signal shall be sent to the plant PLC for operator notification. The pump shall automatically shut down in the event a leak is detected. Each pump shall be affixed upon a spill containment pan as part of the pump support table as shown in the drawings.

F. Each pump shall include necessary control input cable, output cable and relay output cable.

2.6 PUMP ACCESSORIES

A. Mounting and Connections: Components shall include metering pumps with integral controllers and motors, control cables, sample valves, pressure gauges with diaphragm seals, shut-off valves, injection check valves, PE tubing for suction and discharge connections, valved and graduated calibration columns in pump suction, flushing connection valves for

periodic flushing of the line. Each pump smaller than 8 gph shall shall include a multifunction valve to provide necessary pump backpressure, pressure relief and anti-siphon capabilities.

1. There shall be one calibration column per chemical pump system.
2. All wiring integral to the chemical metering pumps shall be provided.
3. All pipe connections must be firmly supported from a secure pipe support as indicated on the drawings to avoid any stress on the piping system.

2.7 SPARE PARTS

A. The Contractor shall furnish a complete set of spare check valves and a diaphragm for each configuration of metering pump.

2.8 MANUFACTURER

A. Manufacturer's Experience: The chemical feeding equipment shall be the product of a manufacturer who has designed and manufactured similar equipment and has a record of at least 5 years of successful operation of this type of process. The Contractor may be required to submit evidence to this effect together with a representative list of installations. The pump manufacturer shall maintain a permanent, local service department and a spare parts department. Pump must be supplied by local distributor responsible for parts, service and warranty claims.

B. Manufacturers or equal:

1. Grundfos, DDA Smart-Dose, AR or FC Control Variant
2. Blue-White Industries, Model MD3 or MD1

C. The fabricator of the pump skid system may be different than the pump manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pumping equipment shall be installed in accordance with manufacturer recommendations and shop drawings and as shown on the drawings.

B. General installation requirements shall be as specified in Section 43 20 10 – Pumps, General, and Section 46 33 00 – Chemical Feeding Equipment, General.

END OF SECTION

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SECTION 46 33 50
ON-SITE SODIUM HYPOCHLORITE GENERATION SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers the work necessary by the Contractor, On-site Sodium Hypochlorite Generation System (OSHGS) Supplier, to furnish, install, test and make ready for operation an On-site Sodium Hypochlorite Generation System. The Generation System includes, but is not limited to the Sodium Hypochlorite Generator Skid with integral piping, valves, system control cabinet with PLC as well as ancillary equipment as specified herein, installation, related testing, start-up and training services.

B. Generally includes OSHGS with the main generation system currently sized for 80-100 ppd with all piping and ancillary equipment sized for 200 ppd.

C. All electrical, mechanical, metal, painting and instrumentation work included herein shall conform to the applicable Sections or Divisions of this project except as otherwise shown or specified. The standard for pipe and conduit for the skid interconnect is; schedule 80 PVC.

D. The Drawings show details of the components and their overall relationships. Not all items incidental to the OSHGS are shown or specified. It is the intent of these Contract Documents that the OSHGS Supplier is to provide a complete and workable system whether or not any specific component is shown or specified.

E. Power shall be provided by the contractor to the system control panels as shown on the OSHGS skid drawings. The contractor shall be responsible for providing all necessary conduit and wiring necessary for a complete electrical service to this location. All wiring shall comply with the National Electrical Code, 1996 edition.

F. The OSHGS Supplier shall furnish the following components of the OSHGS Generation System:
1. Sodium Hypochlorite Generation cells and rectifier
2. Interconnect piping, valves, solenoid control valves and accessories
3. Control cabinet, PLC, VFD's, networking communication components, and associated equipment

Water Softener (sized for 200 ppd OSHGS)
4. FRP Salt/brine Tank (~575 gallon) and accessories
5. Hydrogen Dilution System – dilution blowers & air flow switches
6. Hydrogen Gas Detector
7. Heat Exchanger and Water Heater Systems
8. Acid cleaning Cart/System
9. Cartridge Filters (3) - For Brine and Potable Water – Before/After Softener

G. The requirements of Section 11 00 00 - Equipment General Provisions apply to this Section.

1.2 SUBMITTAL PROCEDURES

A. Submittals shall be made in accordance with Section 01 33 20 –Submittals Procedures

B. Shop Drawings as required for the fabrication and installation of all the Generation System equipment in accordance with the following:
   1. Manufacturer/Supplier's literature, illustrations, Specifications and bill of materials for each component of the system. Data shall include a complete description in sufficient detail to permit comparison with the technical Specifications.
   2. Dimensions including anchor bolt layout, materials, size, weight and performance data.
   3. Drawings showing fabrication, assembly, installation and wiring diagram. Wiring diagrams shall consist of, at a minimum, of control schematics; including coordination with other electrical control devices operating in conjunction with the Sodium hypochlorite generator feed system.
   4. Motor Data: For each motor furnish a certified motor data sheet for the actual motor.
   5. Pump Data: For each pump furnish a performance certification indicating: head, capacity, efficiency and horsepower.
   6. A list of all parameters, ratings or other characteristics where the proposed Sodium hypochlorite generator system deviates from the requirements set forth in these Specifications.
   7. Affidavits of compliance with referenced standards and codes.
   8. Manufacturer/supplier's standards for Sodium hypochlorite generator system equipment.
   9. Process flow diagrams.
   10. Dimensioned inlet/outlet system connections.
   11. The acceptable range of water pressure for proper system operation. If a pressure or flow regulator is required, it shall be provided.

C. Spare Parts List: The Contractor shall obtain from the manufacturer and submit at the same time as Shop Drawings a list of manufacturer suggested spare parts for each piece of equipment specified. The Contractor shall also furnish the name, address and telephone number for the nearest distributor for each piece of equipment.

D. Operation and Maintenance Manual: Provide technical operation and maintenance manuals in accordance with Section 01 33 20 –Submittal Procedures and as follows:
   1. Required Operation Data:
      a. Complete, detailed operating instructions for each piece of equipment
      b. Explanations for all safety considerations relating to operations
      c. Recommended spare parts lists
   2. Required Maintenance Data:
      a. Maintenance data shall include all information and instructions required by plant personnel to keep equipment properly cleaned, lubricated and adjusted so that it functions economically throughout its full design life.
      b. Explanation with illustrations as necessary for each maintenance task
      c. Recommended schedule of maintenance tasks
      d. Lubrication charts and tables of alternate lubricants
      e. Troubleshooting instructions
      f. List of maintenance tools and equipment
      g. Name, address and phone number of manufacturer and manufacturer's local service representative.

E. Special Tools: provide one (1) set of all special tools required to complete assembly or disassembly of the system components.

1.3 QUALITY ASSURANCE

A. OSHGS Suppliers Qualifications:
   1. Assume full responsibility for the completeness and proper operation of the OSHG.
   2. The OSHGS Supplier shall have experience in furnishing equipment of similar capacity and service capability to the equipment described herein. As part of their submittal package, the system manufacturer shall submit the following:
   3. Evidence of at least 10 years' experience with on-site sodium hypochlorite generation equipment ranging in capacity from 20 to 24000 pounds per day of 100% chlorine equivalent.
   4. Evidence that equipment of similar design has been in successful operation in at least ten separate installations for at least five years within the continental United States.
   5. Current NSF Standard 61 Certification for the system being offered.
   6. Supply units containing all necessary appurtenances and components for a complete and operating system confirming to this specification. The Sodium hypochlorite generation equipment shall be pre-assembled and factory tested to assure compliance with all operational requirements. The OSHG System shall be shipped as a single unit. Loose hypochlorite generation components shall not be acceptable. No field assembly or wiring will be permitted with the exception of external conduits. Equipment footprint as shown on the drawings shall not be exceeded.

B. The Contractor shall install the OSHGS, as specified in this specification and as shown on the drawings. The Contractor shall be responsible for connecting all conduit, wire, pipe, etc. for the OSHGS supplied equipment to the project equipment, including piping from the feed pumps to the injection points to provide a complete and fully operational OSHGS.

C. The OSHGS Supplier shall inspect the installation of the Generation System and the Contractor shall correct any deficiencies. Following the correction of all errors, the OSHGS Supplier shall provide a Certification of Proper Installation for the Generation System.

D. The OSHGS Supplier shall be responsible for programming the Generation System package control software. The OSHGS Supplier will define the PLCs for use in the OSHGS (Allen Bradley MicroLogix 1400 with embedded Ethernet/IP).

E. The OSHGS Supplier shall perform functional, performance and start-up testing of the Generation System. The Contractor shall schedule the OSHGS Supplier and notify the Engineer Owner and at least 14 days before the scheduled date for performing these tests.

F. The OSHGS Supplier shall train Owner's personnel and provide detailed instructions in the operation of the Generation Equipment.

1.4 REFERENCES

A. The following references apply:
   1. American National Standards Institute (ANSI).
   2. American Society for Quality Control (ASQC).
   3. American Society of Mechanical Engineers (ASME).

4. American Society for Testing Materials (ASTM).
5. American Water Works Association (AWWA).
6. British Standards Institute (BSI).
7. Canadian Standards Association (CSA).
8. The Chlorine Institute (CI).
9. Confinement of Substances Hazardous to Health (COSHH).
10. European National Standard (EN).
11. Institute of Electrical and Electronics Engineers (IEEE).
12. International Standards Organization (ISO).
13. Member States of the European Council (EC).
14. Mine Safety and Health Administration (MSHA).
15. National Electrical Code (NEC).
16. National Electrical Manufacturers Association (NEMA).
17. National Fire Code (NFC).
18. National Institute of Occupational Safety & Health (NIOSH).
19. Occupational Safety and Health Administration (OSHA).
20. Standard Fire Code (SFC).
21. Uniform Fire Code (UFC).
22. Water Environment Federation (WEF).

1.5 SYSTEM DESCRIPTION

A. Service: Surface water treatment plant disinfection.

B. Feed Points: Under normal operating conditions, site generated sodium hypochlorite solution (nominally 0.8 percent [±0.05%] by weight) will be injected into the process at locations shown on the drawings for disinfection.

C. Functional Requirements:
1. Instrumentation, controls, logic, programming, interlocks and valving shall be provided by the OSHGS Supplier as required for the system to operate as described below.
2. General arrangement, piping sizes and accessories are shown on the Contract Drawings.

D. Generator Operation
1. The generator shall automatically start and stop based on the high and low levels in the sodium hypochlorite solution tank.
2. The water softener resin shall automatically be regenerated with salt solution from the brine tank.
3. The generator shall shut down and alarm for the following conditions:
   a. Low electrolyte level in cell
   b. Hypochlorite temperature exceeds 130°F (55°C)
   c. Inlet flow falls below a preset value
   d. Rectifier high or low amperage.
   e. Rectifier high temperature
   f. Hydrogen dilution blower failure
4. The following additional alarms shall be provided on the control panel:
   a. Low-low level for Hypochlorite Storage Tank

b. High-high level for Hypochlorite Storage Tank

1.6 HYDROGEN SAFETY MANAGEMENT

A. The generators shall have no waste products associated with its use other than hydrogen gas, which is to be vented to the atmosphere. Hydrogen Dilution blowers will be used to purge all residual hydrogen out of the system and storage tanks and dilute the hydrogen concentration 100 to 1 or below 25% of the LEL.

B. Any proposed system must meet every operational and material aspect of this specification. Hydrogen management shall be accomplished by the passive venting of each electrolytic cell without potential restrictions. This flow path should not have baffle plates, orifice plates or backpressure valves between the last point of product generation and atmospheric evacuation.

C. The presence of over-pressure rupture disks is not acceptable as the initiation of disk rupture would render the system inoperable. No hydrogen shall be vented directly to the hypochlorite storage tank where an accumulation could occur.

D. Under no circumstance will waste hydrogen be allowed to flow from one cell or cell compartment to the next. All hydrogen must immediately be released from each cell pack.

E. Minimum passive venting capability from each electrolytic cell pack shall be 4.0 square inches for every 100 pounds of chlorine production.

F. The hydrogen dilution system shall dilute the hydrogen concentration to below 25% of the LEL or 1% by volume.

G. Generator skid hydrogen dilution shall include passive vents connected to each cell and blower connected to the vent header. Sodium hypochlorite storage tanks shall be evacuated by blower.

H. Under no circumstance will the Hydrogen Safety Management requirements (Part 2.02) be relaxed or modified as they are critical operator safety features and core to the generator design. NOTE: THIS HYDROGEN SAFETY DESIGN MUST BE MET, REGARDLESS OF ONSITE GENERATOR MANUFACTURER SELECTED, AND WILL BE REQUIRED FOR SUBMITTAL APPROVAL.

1.7 WARRANTY REQUIREMENTS

A. Prior to acceptance of the Sodium hypochlorite generator system, provide written warranty from the OSHGS Supplier that includes the following statements:
   1. OSHGS Supplier has inspected the installation during and after completion and the Sodium hypochlorite generator system is free from faults and defects and is in conformance with the Contract Documents.
   2. OSHGS Supplier must provide the following after sales services:
      a. Must provide a 24-hour 365-day toll free service hot line.
      b. On site technician availability.
      c. Same day or overnight parts availability.

d. Must provide evidence of spare parts availability on this system such as electrodes, rectifiers, control cabinets, metering pumps.

3. Sodium hypochlorite generator system will remain free of defects for a period of three (3) years from the date of final acceptance and all other equipment supplied for one (1) year
4. The electrolytic cells including cell body shall have a three (3) year full replacement warranty and a prorated straight-line replacement warranty for years 4-7 from the date of final acceptance.
5. The warranty period shall start from the date of commissioning of the system.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Provide one sodium hypochlorite generator system, capable of generating on-site sodium hypochlorite solution (concentration range of 0.8% ±0.05%). All wetted components, materials and equipment in contact with finished, potable water shall conform to the applicable NSF requirements (60 or 61).

B. Not included in the OSHGS package:
1. Sodium hypochlorite system will have a 2,500 gallon storage tank supplied by Contractor, with space for future 2,500 gallon tank. Tank has a mounted level sensor connected to main plant PLC.
2. The sodium hypochlorite feed pumps will also be provided by the Contractor and controlled with the main PLC.

C. The electrolytic system shall generate an aqueous solution of a maximum concentration of 0.8% (± 0.05%) by weight sodium hypochlorite expressed as chlorine. The minimum capacity shall be demonstrated to be equal to the capacity specified for each installation while not exceeding the maximum raw material quantities.

D. Generator performance is to be measured as a function of total consumption for salt and power. Expected ranges of consumption for salt will be 2.5-3.0 pounds of salt and 1.8-2.4 KWH per pound of equivalent chlorine (PE). Product concentration will be in the range of 0.80% ±0.05%. Solar salt shall contain no organic binders, flow control agents, or resin cleaning material and meet the following specifications:

COMPONENT	WEIGHT
Sodium Chloride (dry basis)	99.7% minimum
Insolubles	0.15% maximum
Surface Moisture	0.20% maximum

E. Performance will be measured as the sum of the unit measurements for salt (PPE) and power (KWHPPE) and will not exceed 6.0 consumable units. Example: salt consumption at 3.0 PPE and 2.0 KWHPPE will measure 5.0 consumable units and will be considered proper

performance. Note that electrolytic cells require an initial acclimation period of approximately 300 operational hours. Performance measured before the calls have completed this exercise may not satisfy specification requirements. Water softener salt consumption and or chiller or heater power consumption will be excluded from the calculation. Incoming process water must be potable, less than 10 PPM hardness and temperature must be in the range of 55-78°F. Higher temperatures will result in lower efficiency and a higher total consumable value. A minimum of 60 psi water pressure is required at the inlet to the water softener.

F. The electrolytic cell shall consume in the range of 14.0-17.0 gallons of water per pound of chlorine equivalent output. The raw water supply to the softener shall be potable and free of organics and suspended solids.

G. The generator shall have no waste products associated with its use other than hydrogen gas, which is to be vented to the atmosphere, and the periodic backwash discharge (liquid waste product) from the water softener. Hydrogen Dilution blowers will be used to purge out all residual hydrogen out of the system and storage tanks.

H. The generator package shall be mounted in the general location shown on the drawings and shall be factory wired, plumbed and mounted on a self-contained skid assembly.

I. The process shall operate in a batch environment allowing for consistent hypochlorite concentrations and greatest efficiencies.

J. The generator package shall consist of the electrolytic cells, electrolyte management system, rectifier cabinet, control panel containing system controls, and all necessary interconnecting wiring and hardware.

K. The generator package shall have the following redundant interlocked safety features:
1. Cell high temperature switch.
2. Cell low level switch, for each cell
3. Water flow sensor
4. Transformer high temperature switch
5. Automatic current regulation

L. The rack mounted flow control panel will consist of a water rotameter, water sensor, brine rotameter and a positive displacement gear pump with variable speed drive.

M. The variable speed drive will respond to a 0-5 VDC signal generated by the PLC algorithm in order to maintain constant current relative to variable water temperature or flow rate.

N. The generator skid will be supplied with a 4-20 MA electrolyte temperature sensor that will function to return a linear signal proportional to 0-100°C, which will allow continuous operation up to 130°F without interruption. Under no circumstance will bimetaic “snap” switches be permitted as the primary over-temperature sensor.

2.2 ELECTROLYTIC CELLS

A. Multiple electrolytic cells shall be provided as follows:

SYSTEM I.D.	CELL QUANTITY	CELL CAPACITY	ACTIVE SURFACE
OSG-1750	• 2 Cells Initially Supplied in this Scope • 5 Total Cell Spaces Provided on OSHG Skid Unit	40	4" x 12"

Any system using fewer electrolytic cells than that specified above must demonstrate its ability to achieve 80% production capacity with one of the cells removed from service.

B. The electrolytic cells shall be constructed of clear acrylic materials, allowing for front and rear visual inspection of the electrodes.

C. Each electrolytic cell will be constructed utilizing DSA coated titanium anodes and titanium cathodes. The cells are to be configured in a vertical or horizontal format with a recirculating loop provided for each cell. This recirculating loop will allow the passive removal of hydrogen from each cell via the upper hydrogen vent. Under no circumstance will hydrogen be allowed to be driven from one cell or cell loop to the next.

D. Each cell loop will also incorporate a level sensor so as to preclude any possibility of exposing an active electrode surface.

E. All D.C. cable connections will be direct to the outermost electrode for both anode and cathode. High current bus configurations will not be allowed to penetrate the electrode housing.

F. The wetted cell components will consist only of the electrodes and acrylic cell body. No internal baffles, spacers or connecting hardware will be allowed.

G. Maximum allowable cell current density shall be no more than 1.25 amps per square inch. The OSHGS Supplier shall provide calculations showing all relevant cell data. Data shall include electrode area measurements, and current flows. Electrode service factor shall be expressed as amps per square inch of active electrode surface.

H. The Electrolytic Cells shall be mounted for clear and easy access on the OSHGS skid.

2.3 CONTROL SYSTEM

A. The OSHGS Supplier shall provide a NEMA 4X,304 stainless steel, Sodium Hypochlorite Control Panel, which shall include controls for the entire sodium hypochlorite generation and feed system. The panel shall be mounted onto the generator skid and pre-wired at the factory to system components.

B. All controls and operation logic specified herein and as shown on the instrumentation loop diagrams required for the system shall be programmed in a Programmable Logic Controller (PLC). The PLC shall be Allen Bradley MicroLogix 1400 with embedded Ethernet/IP.

Contractor shall coordinate with OSHGS Supplier and instrumentation supplier for proper integration of the system.

C. Operator interface will monitor residual chlorine measurement. Residual chlorine measurement signal will come from the Chlorine Analyzer (supplied and installed by Contractor) as an isolated 4-20 mA analog signal. Operator interface will allow Operator to enter residual chlorine Set Point and process control parameters.

D. The control signal to VFD (metering pump dose) will be increased if last measurement approaches the Set Point. A bigger deviation from set point creates bigger changes to the pump signal. The "changes" to the output will be smaller as Measurement approaches the Set Point. The "changes" to the output will change polarity (dose will be decreased) if control signal over-shoot, i.e. last measurement is above Set Point

E. The control panel shall display all relevant operating parameters and/or alarm conditions.

F. The control panel cabinet will be UL 508 approved and house the operator interface terminal (OIT), PLC, VFD's, hydrogen blower controls, and terminal strips to fully support the functions of generator operation, tank level and metering pump proportional control.

G. The OIT shall have the following features as a minimum:
1. Context sensitive help screens for each alarm parameter
2. Allen Bradley Panel View Plus 7
3. Serial communications port for PLC connection
4. Ethernet communications port to allow for VNC view from plant network.

H. The control cabinet logic will function at the PLC level where operating parameters will be measured, corrected, scaled, reported and controlled. The OIT will serve as the operator interface, data input screen, and alarm log.

I. The control cabinet to have a 4-port ethernet network switch, N-tron or Equal.

J. The generator PLC and display will control and monitor all functions and operational parameters including, but not limited to, the following:
1. The generator shall automatically start and stop based on the high and low levels in the sodium hypochlorite storage tank.
2. The generator shall shut down and alarm for the following conditions:
    a. Low electrolyte level in cell.
    b. Hypochlorite temperature exceeds 130°F (55°C).
    c. Inlet flow falls below a preset value.
    d. Rectifier high or low amperage.
    e. Rectifier high temperature.
    f. Hydrogen dilution blower failure.
3. Low-low level alarm for hypochlorite storage tank.
4. High-high level alarm for hypochlorite storage tank.
5. Enclosure cabinet, 24" x 24" x 8", with ample interior volume so as to be easily wired and serviced.

6. 6" color touchscreen human-machine interface (HMI) with dedicated screens, including help dialogs covering all basic operations and detailed alarm explanations, for each portion of the process and Ethernet communications for PLC connection.
7. Allen Bradley MicroLogix 1400 programmable logic controller (PLC) with Ethernet communication protocol.
8. Rectifier controls.
9. Blower controls.
10. Analog inputs from the flow meter and residual analyzer to drive each VFD based on the appropriate flow, residual, or compound loop algorithm.
    a. Under no circumstances will external controllers be allowed to control the VFD output.
11. Logging and storing alarm history.
12. Security protection.
13. Dedicated 24 VDC power supply for PLC and HMI.
14. Emergency stop pushbutton.
15. Cabinet-mounted electrical disconnect switch.
16. Start-up shall be accomplished without the need for a laptop computer or proprietary software.

K. The OSHGS Supplier shall be responsible for programming the Generation System package control software. The OSHGS Supplier shall deliver to the Owner's Integrator all PLC and HMI code for future reference prior to final acceptance.

2.4 ON-SITE SODIUM HYPOCHLORITE GENERATOR SKID SYSTEM

A. Provide one sodium hypochlorite generator feed system with an initial capacity of 80-100 pounds per day of equivalent chlorine, with capacity for future expansion to 200 pounds per day. Rectifier, piping and blowers shall be sized for 200 pounds per day. System shall have capacity for future expansion to 200 pounds per day by adding cells. The generator feed system shall include at minimum two electrolytic cells operated in series and shall be factory skid mounted on a stainless steel skid, with space for three future electrolytic cells.

B. The generator package shall consist of electrolytic cells, electrolyte management system, stainless steel rack with flow control panel, rectifier cabinet, PLC-based control system, HMI display, water softener with flow meter, and all necessary interconnecting wiring, hardware, piping, fittings, etc.

C. The generator will be built and configured to allow one of the electrolytic cells to be removed (replaced with a pipe spool) and still run at 80% production capacity with only minor adjustments to the required generator controls.

D. Each generation system shall be pre-piped, wired and skid mounted. The OSHGS skid frame shall be constructed of 304 stainless steel. The skid frame shall be configured to allow easy access to all components. All vertical and horizontal frame connections shall be welded.

The skid frame shall support as a minimum the following mounted equipment:

1. Generator electrolytic cells
2. Power supply/rectifier

3. Water and brine rotameters
4. Control panel
5. Interconnect pipes valves and fittings
6. Interconnect conduit and wiring
7. Water flow sensor
8. Variable speed brine pump.

2.5 TRANSFORMER RECTIFIER

A. The 6-pulse D.C. Rectifier will consist of a fully isolated three phase step down transformer and bridge rectifier. D.C. voltage output will be fixed with multiple primary taps for ± 5-10% voltage correction. Under no circumstance will switching rectifiers or phase angle fired SCR voltage correction be permitted. D.C. ripple will be less than 4% with a power factor of 99% or better.

B. The transformer rectifier will be a fixed voltage unit where the current will be allowed to float as a function of electrolyte conductivity.
1. Constant current will be achieved via an active feedback loop where rectifier amperage is measured and reported to the PLC. The control algorithm calculates the appropriate amount of brine to mix with the incoming water so as to maintain constant current.

C. Rectifier efficiency will be 93% or greater.

D. Each transformer/rectifier will also house a 4-20 mA D.C. current transducer and NEMA 4X digital display of amperage.

E. The rectifier cabinet and base frame will be constructed of 304 Stainless Steel and will be of a modular design. All internal wiring connections and components will be easily accessible by removing the front access panel.

F. The transformer enclosure will be removable from the skid assembly as one piece, allowing for unobstructed access to the transformer.

G. The transformer rectifier shall be provided with the following accessories:
1. DC bridge utilizing three diode assemblies and an aluminum heat sink with 120 VAC cooling fan.
2. Panel-mounted electrical disconnect switch.

H. The transformer rectifies shall be designed for the following operating conditions:

TRANSFORMER I.D.	CAPACITY (KVA)	PRIMARY VOLTAGE	SECONDARY VOLTAGE
	12	480VAC/3PH/25A	300VDC @ 40ADC

2.6 WATER SOFTENER

A. A dual-tank automatic water softening system shall be provided to remove hardness in the feed stream to the OSHGS, plus provides brine water makeup. The softener shall be designed for the following operating conditions:

SOFTENER I.D.	DUAL TANK DIMENSIONS	EFFICIENCY*	KINETICO MODEL NO.
OSG-1753	17" ø x 46" H	4,000	CP-208S

*Expressed as grains exchanged per pound of salt

B. The water softener shall be dual tank, continuously operational and capable of automatically regenerating without the use of electrical timers or gear motors. Regeneration cycles shall be flow dependent only.

C. Softener shall remove hardness to less than ½ gpg. One tank will be on-line during service. A water meter shall automatically initiate system regeneration. The water meter shall measure the processed volume and be adjustable. Water softeners that regenerate on a fixed time will not be acceptable. When the ion exchange capacity of one resin tank is nearly exhausted, the hydraulically-driven, flow-controlled switchover valve will automatically divert flow to the alternate tank while initiating brine backwashing of the first tank for regeneration of the ion exchange resin. During regeneration cycles, one tank shall provide water to service and to the regenerating tank. Regeneration shall use salt solution from the brine tank.

D. The regeneration control valve shall be top mounted (top of media tank), and manufactured from non-corrosive materials. Control valve shall not weigh more than four pounds. Control valve shall provide service and regeneration control for two media tanks. Inlet and outlet ports shall accept a quick connect, double O-ring sealed adapter. Interconnection between tanks shall be made through the regeneration valve with a quick connect adapter. Control valve shall operate using a minimum inlet pressure of 25 psi. Pressure shall be used to drive all valve functions. No electric hook-up, electric timers, or gear motors shall be required. Control valve shall incorporate four operational cycles including; service, brine draw, slow rinse, and a combined fast rinse and brine refill. The brine cycle shall flow shall be opposite the service flow, providing a countercurrent regeneration. Control valve shall contain a fixed orifice eductor nozzle and self-adjusting backwash flow control. The control valve will prevent the bypass of hard water to service during the regeneration cycle.

E. The tanks shall be designed for a maximum working pressure of 125 psi and hydrostatically tested at 300 psi. Tanks shall be made of polyethylene and reinforced with fiberglass wrapping. Each tank shall include a 2.5 in. threaded top opening. Upper and lower distribution system shall be of a slot design. Distributors will provide even flow of regeneration water and the collection of processed water.

F. Each softener shall include a non-solvent, high capacity cation resin having a minimum exchange capacity of 30,000 grains/ft^3 when regenerated with 15.0 lbs/ft^3. The media shall

be solid, of a proper particle size and shall contain no plates, shells, agglomerates or other shapes, which might interfere with the normal function of the water softener.

G. The water softener shall be provided with the following accessories:

1. 1-1/2-inch inlet and outlet pipe connections.
2. 1/2-inch HDPE tube with in-line check valve for feeding brine for regeneration.
3. 1/4-inch wastewater discharge to sewer for backwash waste.

H. Acceptable Manufacture- Kinetico CP 208s

2.7 BRINE TANK [PNEUMATIC FILL FRP]

A. A fiberglass-reinforced plastic (FRP) salt/brine storage tank shall be provided for the following operating conditions:

TANK I.D.	DIAMETER	WALL HEIGHT	BRINE CAPACITY (GAL)	SALT CAPACITY (LBS)
TNK-1998	5'-0"	3'-10"	575	2,000

B. Design Criteria

1. The brine tank vessel shall be designed for pressure service conditions as specified for Type I Grade 1 tanks in ASTM D 3299. Brine tank vessel shall conform to the following structural design criteria:

Working Pressure: Hydrostatic load of SG 1.2
Wind Load: 100 mph
Maximum Temperature: 140 °F

A 10:1 safety factor shall be used for internal pressure loadings and a 5:1 safety factor shall be used for external and vacuum loadings.

C. Quality Assurance

1. Tanks shall be manufactured in an RTP-1 Accredited manufacturing facility.
2. Visual defects shall be better than Level II on the inside of the vessel and better than Level III on the outside in accordance with ASTM D 2563 Table 1.
3. The manufacturer shall have been regularly engaged in the design and manufacture of brine make-up and storage systems tanks such as specified herein for at least five years. The manufacturer's experience shall include at least fifteen installations of equal or larger capacity than specified herein, that have been in operation for at least five years.

D. Materials and Construction

1. The brine tank shall be vertical and consist of FRP vessel, salt fill line, water distribution system, outlet plenum, salt and brine level controls, and all

internals. The brine tank shall be cylindrical with a flat bottom and domed top. Vessel size and configuration shall be as shown on the drawings. Unit shall be complete with flanges, nozzles, manways, lifting lugs, anchor lugs, and other appurtenances.

2. The vessel shell shall be helically filament wound according to ASTM D-3299. Any shell fabrication by hand lay-up shall not be acceptable. Only the tank bottom and dome may be fabricated by hand lay-up. Any tank made of PVC, polypropylene, or any other material shall not be acceptable. Contact molded components and accessories, shall be fabricated in accordance with ASTM D 4097 and NBS PS 15-69. The resin used shall be a premium isophthalic polyester type such as AROPOL 7241 T-15 by Ashland Chemicals or approved equal. The resin will be exposed continuously to a saturated brine solution.
3. All non molded surfaces shall be coated with resin incorporating paraffin to facilitate a full cure of the surface. All cut edges, bolt holes, secondary bonds shall be sealed with a resin coat prior to the final paraffinated resin coat. All voids to be filled with a resin paste.
4. The laminate shall consist of a single resin rich layer, with either c-veil or Nexus 111-00010 reinforcement followed by two 1-1/2-ounce layers of -1/2-ounce layers of random chopped strand glass, fully wetted out with resin. This interior surface shall yield a minimum 100-mil thick corrosion barrier. Filament wind over this to the required thickness. Exterior surface coat shall be paraffinated. Vessels shall be surface coated on the exterior with gel coat containing ultra violet light such as UV-9. No thixotropic or other additives shall be used.
5. Other than those associated nozzles, couplings, manways, and top and bottom heads, the towers shall be filament wound in one piece with no more than one joint.
6. The minimum properties of filament wound laminate shall be as specified in ASTM D 3299.
7. 24" diameter manways shall be in accordance with ASTM D 3299. As a minimum, two manways (lower side, top) shall be provided for each tank. The top manway cover shall include over-pressurization relief protection.
8. Flanged nozzles, double flanged gusseted nozzles, bottom drain nozzle, and threaded full couplings shall be provided as required. Flanged nozzles with 1/8-inch thick EPDM full-face gaskets of 60 durometer shall be provided by the supplier. Press-molded flanges are not acceptable. Threaded full couplings shall be FRP.
9. The tank shall include salt fill connection, softener water connection, brine outlet connection, drain, overflow, salt level indicator, brine level indicator, and vent.
10. The minimum properties of contact molded laminate shall be as specified in ASTM D 4097.
11. Anchorage: Each tank shall be furnished with concrete anchors and hold down lugs, complete with 304 stainless steel plates, for proper anchoring of the tank as required by the design calculations. A minimum of four (4) hold down lugs shall be provided.
12. Unless otherwise specified, all fasteners, and metal attachments, such as anchors, brackets, etc. shall be ANSI 316SS.

13. If necessary based on installation location, vessels designed for outdoor use shall have the bottom 6'-0" of straight sheel insulated for protection against freezing. Insulation shall be 2" thick polyurethane foam and be covered with a 1/8" thick FRP protective covering and receive a white pigmented gel coat with UV inhibitors. The top of the insulation will be capped to seal out any moisture.

E. Accessories

1. The brine tank shall be provided with a full-radiused Sch 40 304 stainless steel salt fill line designed to receive salt pneumatically unloaded from a truck. Long-radius fittings shall be used. One aluminum quick connect adapter and cover shall be provided to connect the truck's hose to the brine tank salt fill line as indicated on the drawings. One gooseneck vent shall be integrally molded into the brine tank dome. A vent dust collector bag shall be furnished and installed. The dust collector shall be properly sized for the salt fill rate and the brine tank capacity. The dust collector shall be polyester cloth material.
2. A water distribution system and a brine collection plenum shall be provided. Each assembly shall be securely installed in the brine/salt storage tank. Each assembly shall be designed to produce a saturated brine solution as required by the hypochlorite generators.
3. The brine tank shall be provided with a liquid level control assembly, including:
    a. A pressure sensing-type electronic level transmitter.
    b. Normally-closed, solenoid pilot-operated diaphragm valve shall have a brass body be ASCO 8210 Series. The solenoid valve shall open when brine solution level in the Brine Storage Tank is low. The solenoid valve shall close when the brine solution level in the Brine Storage Tank is high.
4. For tanks using granular or fine grade (less than 12 mesh) solar salt, a quartz rock filter bed shall be installed in the sump. The filter bed shall consist of a 5" layer of 0.125" x 0.125" on top of a 7" layer of 0.250" x 0.250". The filter bed shall be evenly-distributed over the entire bottom of the vessel. All quartz rock shall be AWWA-washed and NSF-certified.
5. The salt level sensor shall be a cable measurement transmitter. Cable measurement transmitter shall continuously measure salt level in the brine tank with 0.25% accuracy. Measuring cable length shall extend the entire height of the brine tank to measure salt at all levels. The cable shall be constructed of material resistant to saturated brine. Transmitter shall be Bin Master "Smart Bob II A.O." or equal.
6. For tanks with straight shell greater than 12'-0", an OSHA-approved fiberglass ladder with safety cage shall be provided. The ladder shall be mounted to the vessel, but fully supported by concrete or other suitable support base. Attachment fasteners shall be stainless steel.
7. A fiberglass-encapsulated nameplate shall be provided. At a minimum, the nameplate shall include the following information:
    1) Project name
    2) Installation location

3) Service
4) Specific gravity
5) pH
6) Pressure rating
7) Temperature rating
8) Resin
9) Size
10) Capacity
11) Shipping Weight
12) Date of manufacture

8. Unless otherwise specified, all pipe and fittings shall be Sch 80 PVC and all fasteners stainless steel.

2.8 SODIUM HYPOCHLORITE STORAGE TANK (NOT INCLUDED IN THIS PACKAGE)

A. The Contractor shall supply and install one 2,500 gallon hypochlorite storage tank. See Specification 43 41 43 POLYETHYLENE TANKS.

B. The Contractor shall supply the polyethylene sodium hypochlorite solution tank with the following accessories:

1. Level sensor and associated flanged connection. The level transmitter shall provide a 4-20 mA level signal for proper operation of the generation system.
2. Vent connection.
3. Fill connection.
4. Forced air blower connection.
5. Pump suction connection.
6. Drain and overflow connections.

2.9 SODIUM HYPOCHLORITE DOSING SYSTEM (NOT INCLUDED IN THIS PACKAGE)

A. The SH metering pumps shall be supplied and installed by the Contractor.

B. Each pump shall be supplied with a PVC stands, backpressure valve, pressure relief valve, pulsation dampener, wye strainer, pressure gauge and calibration column. See Section 46 33 42 - Diaphragm Type Metering Pumps.

C. The metering pumps shall be controlled by the main plant PLC, as specified in the Drawings.

2.10 HEAT EXCHANGER (MICROCHLOR)

A. The OSHGS shall provide a heat exchanger as part of this equipment package.

B. A titanium and PVC heat exchanger will be provided on the OSHGS rack capable of raising the incoming cold water temperature 8-12°F.

C. The process will function to bleed waste heat from the product hypochlorite to the incoming cold water.

D. A bypass valve will be provided for seasonal adjustment. Additionally, a flushing valve and drain will be provided.

E. All wetted components and fasteners will be titanium and all internal gasketing will be Viton.

F. The heat exchanger will not require power or control circuitry and will function in a completely passive fashion.

2.11 WATER HEATER

A. As part of this equipment package, the OSHGS shall provide an adequately sized water heater to heat the water prior to the OSGHS elements reaching high temperatures. Water heater shall be designed/sized for full future capacity of the OSGHS system.

2.12 HYDROGEN DILUTION AND FLOW SENSOR

A. The hydrogen dilution system shall dilute the hydrogen concentration to below 25% of LEL or 1% by volume.

B. A hydrogen dilution blower shall be designed for the following operating conditions:

BLOWER I.D.	CAPACITY (ACFM)	STATIC PRESSURE (IN WC)	MOTOR HP	ELECTRICAL SERVICE
OSG-1751	163	3.19''	1/2	480V/3Ph/60Hz

C. The blower shall be AMCA type B spark resistant of cast aluminum construction. The blower shall be cast with commercial grade 319 cast aluminum, having a 3/16" minimum wall thickness. Housing halves should be attached with tapered lugs having a minimum 45 degree taper from centerline for additional strength. Inlets and outlets shall be round.

D. The blower wheel hub shall be an integral part of the wheel casting. The wheel shall be a radial-type wheel. The blower shall be statically balanced by removal of material only – no additional weights are to be used in the balancing process.

E. The blower shall be arrangement 4 with a base of 12 gauge steel (minimum).

F. Hydrogen dilution blower shall be PB Series by Cincinnati Fan or equal.

G. The hydrogen dilution blower shall be provided with the following accessories:

1. Inlet guard.
2. Teflon shaft seal.
3. Current sensor.
4. Air flow switch positioned in the dilution ductwork vent stack.
5. Software controlled safety interlocks to detect control system sequence failure.

2.13 HYDROGEN DETECTOR

A. A hydrogen gas monitoring system shall be provided to continuously measure and display gas concentration and provide alarms when preset limits are exceeded. A transmitter will send the signal to the control panel.

B. Hydrogen Gas room monitor / detector shall be provided.
   1. Enclosure: NEMA 4X
   2. Display: Two line, 8 Character, Alphanumeric LCD Display
   3. Output signal: Linear 4-20 mA

C. Acceptable Manufacture and Model: Conspec Controls Model CN06

2.14 ACID CLEANING CART / 7 GALLON SYSTEM

A. A pre-assembled, mobile cart including acid cleaning tank and centrifugal pump shall be provided by the OSHGS Supplier for periodic washing of the electrolytic cells.

B. The cart shall be pre-piped and pre-wired prior to shipment. All piping, fittings, and valves shall be Sch 80 PVC. The 120VAC, single-phase plug shall be included for connection to a standard electrical receptacle.

C. A discharge hose, quick-connect couplings, and appurtenance shall be included to transfer acid to and from the electrolytic cells.

2.15 COMMERCIAL STRENGTH HYPOCHLORITE DILUTION PANEL (NOT INCLUDED)

2.16 TOOLS, SPARE PARTS AND MAINTENANCE MATERIALS

A. The OSHGS Supplier shall furnish, one set of the following spare parts for each installation, with each onsite sodium hypochlorite generator system:
   1. Two (2) electrolytic cell level switch
   2. Two (2) electrolytic cell temperature sensor
   3. One (1) spare parts kit for each metering pump
   4. One (1) set of spare parts kit for the backpressure and pressure relief valves.
   5. One (1) spare brine pump.

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the completion of the contract.

2.17 CARTRIDGE FILTERS

A. A wall-mounted cartridge type filter housings holding a 10" cartridge for dirt, rust, and particulate matter from the brine stream shall be provided. The filter housing shall be feature NPT inlet and outlet connections and mounting bracket that must be non-metallic construction. A polypropylene cap with Buna-N O-ring shall be supplied.

B. 50 micron, suitable for use on both brine and potable water before and after softener.

2.18 MANUFACTURERS OR APPROVED EQUAL

A. Approved Manufacturers or equal:
   1. MicrOclor System as manufactured by PSI Water Technologies, Inc. (a UGSI Company)
   2. Miox as manufactured by De Nora

B. MicrOclor System is the basis of this specification and the design drawings, though Miox units are acceptable if the package system includes the scope of supply, capacity, and performance as outlined in this specification. Miox may require slightly different ancillary equipment than specified herein.

C. Engineer approved equal. Pre-approved equals must be approved by owner and engineer 10 days prior to bid close. Contractors are responsible for all additional costs with selection, design, and installation of an alternate manufacturer, including revision of Contract Drawings (mechanical, process, etc.)

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. The Contractor shall inspect all equipment and materials against approved Shop Drawings at time of delivery. Equipment and materials damaged or not meeting requirements of the approved Shop Drawings shall be immediately returned to the OSHGS Supplier for replacement or repair.

B. The Contractor shall be responsible for the delivery, storage and handling of products in accordance with the manufacturer's recommendations.

C. Equipment and materials shall be stored in a dry location and protected from the elements according to the OSHGS Supplier's instructions.

D. Equipment and materials shall be handled in an approved manner according to the OSHGS Supplier's instructions.

3.2 INSTALLATION

A. Installation of the generator, metering pumps, tanks and appurtenances shall be performed by the Contractor and shall be in accordance with the Drawings and with the OSHGS Supplier’s instructions and recommendations. Conflicts of information shall be called to the attention of the Engineer.

B. All equipment units or assemblies shall be installed on concrete bases and secured with anchor bolts in accordance with the OSHGS Supplier's recommendations and as shown. The concrete bases shall be poured up to 1-inch below the metal bases, legs or soleplates. Equipment legs or base plates shall be accurately shimmed to grade and the spaces between filled with an approved non-shrink grout. After the grout has reached its initial set, exposed edges shall be cut back 2 inches and the edges neatly finished with 1 to 2-cement mortar. Where channel base plates are used, the void inside the channel shall be filled with non-shrink mortar and the open ends plastered with 1 to 2-cement mortar. Contractor shall be

responsible for the design of the equipment pads. The contractor shall coordinate with OSHGS supplier for skid placement and anchoring.

C. Contractor shall inspect all concrete pads for proper elevation, dimensions, cutouts, evenness and anchor bolt locations and correct if necessary.

D. Contractor shall provide a drain for each piece of equipment, according to the OSHGS Supplier's instructions.

E. Installation shall include furnishing and applying an initial supply of lubricants, as provided by the OSHGS Supplier.

F. Contractor shall support piping independent of equipment. Equipment shall be free from all loads and stresses induced by the piping.

G. All equipment including motors, belts and drives shall be aligned to the best industrial standards. Field check and adjust all equipment alignments in the presence of the Engineer.

H. The contractor shall inspect all equipment before installation, if damaged; notify the Engineer and OSHGS Supplier promptly. Do not install damaged equipment until the OSHGS Supplier makes repairs in accordance with OSHGS Supplier's written instruction and approval.
   1. Tie-down lugs for tanks shall be grouted or shimmed to prevent excessive loads being transferred to the tank shell.
   2. Make all electrical connections in conformance with the requirements of the electrical specifications.

3.3 START-UP SERVICES AND TESTING

A. The chlorination equipment manufacturer shall furnish the services of a qualified field engineer to check installation, start-up and instruct operating personnel in the proper operation and maintenance of the equipment

B. Contractor shall verify that structures, equipment, pumps and motors are compatible for an efficient system. OSHGS Supplier is responsible to verify that generation equipment and system controls are integrated for system operation.

C. Contractor and OSHGS Supplier shall make equipment adjustments required to place system in proper operating condition.

D. Contractor and OSHGS Supplier shall test the sodium hypochlorite feed system for proper operation in the presence of the Owner and Engineer.

E. The OSHGS Supplier shall furnish all testing equipment and devices required.

F. If the sodium hypochlorite generation system fails to meet any of the specified performance requirements, Contractor and/or OSHGS Supplier shall modify and/or replace defective equipment until it meets specified requirements. Re-test system to verify satisfactory operation.

G. The OSHGS Supplier's field services:

1. Retain, for a period of not less than two (2) days for installation of each generation system, factory trained representatives of the manufacturer of each component with demonstrated ability and experience in the installation and operation of the equipment. For each installation, the representative shall perform the services listed below:
   a. Inspect the completed installation and prepare an inspection report.
   b. Test, calibrate and adjust all components for optimum performance.
   c. Assist in initial start-up and field-testing.
   d. Instruct Owner's personnel in the operation and user maintenance of all components. Conduct a training seminar at the site.
   e. Supervise the correction of any defective or faulty work before and after acceptance by Owner.

H. Dosing Pump manufacturer's field services (See metering pump specification):

END OF SECTION

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