

Rio Grande Depot Seismic Retrofit Project Manual

270 South Rio Grande Street
Salt Lake City, Utah 84101

September 6, 2023
DFCM Project #
CRSA Project #

BP-03
20229080
21-031



ARCHITECTURE
PLANNING
INTERIORS

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**SECTION 003100
AVAILABLE PROJECT INFORMATION**

PART 1 GENERAL

2.01 EXISTING CONDITIONS

- A. Certain information relating to existing surface and subsurface conditions and structures is available to bidders but will not be part of Contract Documents, as follows: (Copies are attached as appendix to the project Manual)
- B. Hazardous Material Survey: Entitled Abestos, Lead and Hazardous Materials, dated March 17, 2022.

2.02 PERMITS

- A. Owner has obtained the following permits and/or approvals, that are required to be secured prior to commencement of construction work on this project:
 - 1. Historic Preservation commission approvals.
 - 2. Demolition Permit.
 - 3. Building Permit for all trades.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 003100

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**SECTION 005000
CONTRACTING FORMS AND SUPPLEMENTS**

ADDENDUM #01 OCT 19, 2022

PART 1 GENERAL

1.01 CONSTRUCTION MANAGER IS RESPONSIBLE FOR OBTAINING A VALID LICENSE TO USE ALL COPYRIGHTED DOCUMENTS SPECIFIED BUT NOT INCLUDED IN THE PROJECT MANUAL.

1.02 AGREEMENT AND CONDITIONS OF THE CONTRACT

A. *Gramoll Construction Blank Subcontract Agreement attached*

1.03 FORMS

- A. Use the following forms for the specified purposes unless otherwise indicated elsewhere in Contract Documents.
- B. See DFCM website: <https://dfcm.utah.gov/construction-management/#documents> under Construction Management Documents for applicable forms.
- C. Bond Forms:
 - 1. Bid Bond Form: AIA A310.

1.04 REFERENCE STANDARDS

- A. AIA A310 - Bid Bond 2010.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 005000

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**SECTION 005201
SUBCONTRACT AGREEMENT**

NO. 716XX SUBCONTRACT AGREEMENT

1.01 SUBCONTRACT AGREEMENT

- A. THIS SUBCONTRACT AGREEMENT ("Subcontract") by and between GRAMOLL CONSTRUCTION COMPANY, A UTAH CORPORATION, HEREINAFTER REFERRED TO AS "CONTRACTOR," AND [COMPANY NAME], [COMPANY ADDRESS] HEREINAFTER REFERRED TO AS "SUBCONTRACTOR," IS ENTERED INTO AND SHALL BE EFFECTIVE AS OF THE DATE IT HAS BEEN SIGNED BY BOTH PARTIES HERETO (THE "SUBCONTRACT DATE"). IF SUBCONTRACTOR COMMENCES WORK PRIOR TO SIGNING THIS SUBCONTRACT, THE SUBCONTRACT DATE SHALL BE DEEMED TO BE THE DATE SUBCONTRACTOR COMMENCED THE WORK.

1.02 RECITALS

- A. Contractor has entered into a contract with DFCM for the construction, performance and completion of a certain project known as RIO GRANDE DEPOT SEISMIC UPGRADE said contract being hereinafter referred to as the "General Contract".
- B. Subcontractor desires to furnish, and Contractor desires to have Subcontractor furnish a portion of the work for Contractor. Contractor and Subcontractor desire to establish the terms and conditions that govern the relationship between them when Subcontractor furnishes such labor, materials, and equipment pursuant to this Subcontract.

1.03 ARTICLE I

- A. Scope of Work. Subcontractor shall furnish all labor, materials, permits, tools, machinery, equipment, facilities, supplies and services, pay all applicable taxes, and comply with any and all additional requirements imposed by the jurisdiction in which the work is performed, and to do all things necessary to complete the following items of work under the General Contract (the "Work"):
- B. Furnish all labor, materials, equipment and supervision required to complete all [SCOPE OF WORK] work required, as shown on the drawings in [DOCUMENTS] dated [DATE], for RIO GRANDE DEPOT SEISMIC UPGRADE prepared by CRSA ARCHITECTS, as related to such work.
1. Addenda:
 2. Addenda: Includes: Excludes
 3. Addenda: Includes: Excludes
- C. Hereinafter, all such documents, plus this Subcontract and the General Contract are collectively referred to as the "Subcontract Documents." All Subcontract Documents other than this Subcontract are incorporated herein by reference and hereby adopted and made a part of this Subcontract as fully as if it were set forth in full herein, subject to the limitations set forth in Article I hereof. All General, Supplemental General, and Special Conditions of the specifications and all terms and conditions of the General Contract shall apply to this Subcontract, except where ambiguous or inconsistent with this Subcontract, in which case the provisions of this Subcontract shall control. Subcontractor acknowledges that the Work to be performed by Subcontractor is not confined to any particular portion of the drawings or section of the specifications but may be scattered throughout those documents. In the performance of this Subcontract, Subcontractor binds itself to Contractor to comply fully with all undertakings and obligations of the Contractor to the extent that they apply to the scope of the Work.

1.04 ARTICLE II

- A. Subcontract Price. Contractor shall pay Subcontractor for completion of the Work in accordance with the Subcontract Documents the lump sum of [PRICE] (the "Subcontract Price.") The Subcontract Price includes all costs and expenses to perform the Work, and associated with the performance of the Work, including, without limitation, (1) all applicable transportation charges, costs and expenses, and (2) all applicable taxes including, without limitation, applicable taxes under any law now existing, or which may hereafter be adopted by federal,

state, local or other governmental authorities, taxing the labor, materials, or equipment furnished, or any other tax levied as a result of performance of the Work. The Subcontract Price may be adjusted only as provided for in Article V.

1.05 ARTICLE III

- A. Independent Contractor. The relationship of Subcontractor to Contractor during the term of this Subcontract shall be that of an independent contractor. Subcontractor shall take any and all actions necessary to maintain that independent contractor relationship throughout the term of the Subcontract, and neither Subcontractor nor its employees shall be considered employees of Contractor. Subcontractor shall exercise exclusive control for the means, methods, techniques, and procedures in performance of the Work.
- B. Examination of Subcontract Documents/ Site. Subcontractor has examined the Subcontract Documents and the applicable Laws and Regulations, as that term is defined below, and has examined the site of the work and satisfied itself as to all conditions to be encountered in the performance of the Work. Subcontractor enters this Subcontract on the basis of its own examination, investigation and evaluation of all such matters, and not in reliance on the opinions or representations of Contractor or Owner. If there are any inconsistencies between the Subcontract Documents or ambiguities in any Subcontract Document, Subcontractor shall bring such inconsistencies or ambiguities to the attention of Contractor before the execution of this Subcontract; otherwise, Subcontractor shall be bound by Contractor's resolution of such inconsistencies or ambiguities.
- C. In the event of any discrepancy (1) in the Subcontract Documents, or (2) between the Subcontract Documents and the Laws and Regulations, those which are more stringent, provide persons and property with greater protection, or provide for a better product shall govern. In the event of any discrepancy in the Subcontract Documents between dimensions and measurements for the Work based on scaling, the Work shall comply with the dimensions for such Work. Subcontractor shall promptly notify Contractor in writing of any such discrepancy. To the extent that the Subcontract Documents include plans, specifications or other documents that depict, refer or relate to mechanical, plumbing, electrical or fire protection systems, such documents are diagrammatic only, and are not intended to show the precise alignment, physical locations, or configurations of such Work. The Subcontract Price includes all costs and expenses for such systems to be installed such that they clear all obstructions, permit proper clearances for the Work of other trades, and present an orderly appearance.
- D. Before commencing Work, Subcontractor will satisfy itself as to the location of all utilities that may affect or interfere with Subcontractor's Work. Subcontractor will fully protect all utilities, and keep them operating at all times, unless otherwise provided in the Subcontract Documents. Subcontractor shall take such field measurements as are necessary for the proper execution of its work. It shall be assumed that the Subcontractor has fully accepted the work of others as being satisfactory and he shall be fully responsible thereafter for the satisfactory performance of the work covered by this Agreement, regardless of the defective work of others.
- E. Lines, Levels, Dimensions and Measurements. Subcontractor assumes full responsibility for the proper interpretation and interpolation of all lines, levels, dimensions, and measurements and their relation to benchmarks, property lines, reference lines and the work of Contractor and other trades. In all cases where dimensions are governed by conditions already established, the responsibility for correct knowledge of the condition's rests entirely on Subcontractor. The Work shall comply with the dimensions provided in the Subcontract Documents and shall not be performed based on scales indicated in those documents. No variations from specified lines, levels or dimensions shall be made except on prior written approval of Contractor clearly setting forth the variation.
- F. Shop Drawings/ Submittals. Shop drawings and submittals shall be provided in a minimum of one (1) digital copy to Contractor's office in North Salt Lake. Additional copies shall be provided if required by the Subcontract Documents. Shop drawings and/ or submittals and/ or samples are due within fourteen (14) days of Subcontract's date of issuance. At the time of submission, Subcontractor shall clearly identify in writing any deviation in its shop drawings/ submittals/ samples from the requirements of the Subcontract Documents and must receive from Contractor specific written approval for any deviation.

- G. Warranty. Subcontractor warrants that:
1. all materials and equipment furnished under this Subcontract will be of good quality and new, unless otherwise required or permitted by the Subcontract Documents.
 2. the materials and equipment provided as part of the Work will be suitable for the purposes intended in the Subcontract Documents.
 3. the Work will be performed in a good and workmanlike manner.
 4. the Work will conform to the requirements of the Subcontract Documents; and
 5. the Work will be free from defects.
- H. Work not conforming to these requirements including, without limitation, substitutions not properly approved and authorized, shall be considered defective (all such work, "Defective Work"). Subcontractor shall (1) execute any special guarantees, and (2) assign to Contractor all warranties, as required by the Subcontract Documents.
- I. Correction and Replacement of Defective Work. During performance of the Work, Subcontractor shall promptly correct or replace Defective Work. Contractor shall determine whether Work is defective and whether work performed by Subcontractor to correct or replace Defective Work complies with Subcontractor's warranty obligations.
1. If, within the greater of (1) the period established in the Subcontract Documents, or (2) one year after the Completion Date, (hereinafter the "Warranty Period"), any of Subcontractor's Work is found to be defective, Subcontractor shall correct or replace it promptly after receipt of written notice of the Defective Work. If Contractor prefers to accept, rather than correct or repair Defective Work, Contractor may, in its sole discretion, accept the work subject to its right of reimbursement, as set forth below.
 2. Subcontractor shall pay all costs to correct or replace Defective Work without any adjustment to the Subcontract Price or Subcontract Time. If Subcontractor fails to correct Defective Work within the time allowed by Contractor, or if no time is specified, a reasonable time after receipt of notice of such defects, Contractor may correct or replace the Defective Work. Subcontractor shall reimburse Contractor for (1) the costs to correct or replace defective Work, including, without limitation, the costs of additional sampling, testing and inspections, if any, made necessary by Defective Work, corrections or replacements, (2) all Losses that Contractor incurs that arise out of or result from Defective Work, (3) any amounts assessed and collected by Owner from Contractor for acceptance of Defective Work, and (4) any other amounts for which Subcontractor is responsible at law or in equity.
- J. Safety. Subcontractor shall initiate, maintain and supervise all safety precautions and programs in connection with the Work including, without limitation, such precautions and programs as necessary to comply with the Gramoll Project Safety Rules and Regulations that are expressly made a part of the Subcontract Documents. Subcontractor shall take all necessary precautions to prevent damage, injury or loss to (a) all persons performing the Work or who may be affected by the Work; and (b) all Work, whether stored on or off the Project site. Subcontractor shall promptly report to Contractor all accidents incidental to the Work which result in death or injury to persons or in damage to property. Subcontractor shall provide to Contractor any reasonable documentation requested by Contractor related to any such death, injury, damages.
- K. Compliance with Laws and Regulations. Subcontractor shall comply with and give all notices required by all federal, state, local, and municipal laws, regulations, codes, ordinances, and orders that directly or indirectly bear on the Work and/or the performance of the Work including, without limitation:
1. Building codes and ordinances.
 2. Worker's compensation laws and regulations.
 3. safety laws, codes, regulations and orders, including, without limitation, the Occupational Safety & Health Act of 1970, as enacted and amended, and regulations issued under that act.
 4. environmental laws including, without limitation, the Comprehensive Environmental Response, Compensation and Liability Act, the Clean Water Act, the Clean Air Act, and the Resources Conservation and Recovery Act, as enacted and amended, regulations issued under those acts, and counterpart state laws;

5. wage, hour, labor, and anti-discrimination laws, including, without limitation, the Equal Employment Opportunity (EEO) Executive Order 11246, Title VII of the Civil Rights Act of 1964, the Age Discrimination in Employment Act of 1967, the Equal Pay Act of 1963, the Family and Medical Leave Act, the Americans with Disabilities Act, the National Labor Relations Act, the Fair Labor Standards Act; Sections 503 and 504 of the Rehabilitation Act of 1973, Section 402 of the Vietnam Era Veterans Readjustment Assistance Act of 1974, the Immigration Reform Control Act of 1986, as enacted and amended, and all regulations issued under those acts; and
 6. tax laws and regulations; all as enacted and amended, and all regulations issued under such acts
- L. Collectively, these are referred to in this Subcontract as the "Laws and Regulations."
- M. Subcontractors. Subcontractor shall not assign this contract, in part or in whole, without Contractor's prior written consent, nor shall Subcontractor assign any monies due or to become due to it hereunder, without Contractor's prior written consent. Subcontractor shall, upon request from Contractor at the inception of this Subcontract, provide to Contractor or supplier a written list of sub-subcontractors or suppliers that Subcontractor intends to use in connection with the performance of its obligations under this Subcontract where the dollar amount individually or in the aggregate with the same sub-subcontractor will exceed 5% of the Subcontract Price. Subcontractor shall require all of its sub-subcontractors to comply with the Subcontract Documents to the extent that they apply to the scope of work of such sub-subcontractor. Subcontractor shall not change sub-subcontractors without prior written approval of Contractor.
- N. Upon Contractor's request, Subcontractor agrees to provide documentation evidencing full payment of all sub-subcontractors and/or suppliers engaged by Subcontractor with respect to its performance of this Subcontract.
- O. If this Subcontract is terminated, each of Subcontractor's contracts for performance of the Work shall be assigned to Contractor, provided that Contractor accepts such assignment in writing and assumes all rights and obligations of Subcontractor pursuant to each such contract.
- P. Cleanup. Subcontractor will continuously clean, and remove from the jobsite, its debris and excess materials and at the end of each day will leave its working areas in broom-clean condition. Also, he shall clean up to the satisfaction of the inspectors, all dirt, grease marks, etc., from walls, ceilings, floors, fixtures, etc., deposited or placed thereon as a result of the execution of this Subcontract. If Subcontractor fails to do so, Contractor may perform the cleanup and backcharge Subcontractor for the cost of performing such clean-up.
- Q. Supervision. Subcontractor shall have available on the project, at all times, a qualified superintendent, who is acceptable to Contractor, to coordinate the Subcontractor's work with that of the Contractor and of the other subcontractors, and any instruction given by the Contractor to said representative on the project shall have the same force and effect as if given to the Subcontractor either at the project or at the Subcontractor's office away from the project site.

1.06 ARTICLE IV

- A. Subcontract Time. Subcontractor shall commence and complete the Work in accordance with the most current schedule prepared by Contractor, as may be revised from time to time during the course of the Project (the "Project Schedule"). Subcontractor shall commence and complete all activities in compliance with the time periods expressly provided for such activities in the Project Schedule. The periods of time provided in the Project Schedule for commencement and final completion of all activities that comprise the Work shall constitute the "Subcontract Time." Except as otherwise expressly noted, as used herein and in the Project Schedule, the term "day" shall refer to a calendar day. The date on which all the work performed by Contractor and its subcontractors is completed and accepted by the Owner shall be referred to hereinafter as the "Completion Date."
- B. Subcontractor's commencement, prosecution, and completion of the Work in the Subcontract Time and in compliance with the Project Schedule is of the essence of this Subcontract.

- C. Subcontractor acknowledges that the precise time periods scheduled for its performance are estimates only. Subcontractor shall cooperate with Contractor in scheduling and performing its work to avoid conflict or interference with the work of Contractor or other trades. Contractor reserves the right, in its sole discretion, to extend or to delay the scheduling of Subcontractor's work if such extension or delay becomes necessary in the opinion of Contractor. Each Subcontractor shall review the schedule of all items of work other than his own, to anticipate completion of specific items of its Work as it affects other trades, to be certain that work following Subcontractor's Work is not delayed. In the event of any conflicts in the Project Schedule between the work of Subcontractor and Contractor or another trade, Contractor shall determine, in its sole discretion, which work shall have precedence and how the parties will coordinate their respective work. All other work not specifically scheduled shall be coordinated as necessary to avoid delaying Work as scheduled. Subcontractor shall not be entitled to an adjustment in the Subcontract Price or the Subcontract Time based on the coordination of such activities with Contractor or any determination by Contractor concerning coordination of the work.
- D. If Contractor determines, in its sole discretion, that Subcontractor has failed to diligently prosecute the Work in accordance with the Project Schedule, or that Subcontractor will not complete the Work within the Subcontract Time, Contractor may, in its sole discretion, (1) require Subcontractor to work overtime and/or use such additional labor and equipment as necessary to accelerate the Work and bring Subcontractor's performance into compliance with the Project Schedule, (2) supplement Subcontractor's work by furnishing additional labor and equipment to the Project as necessary to accelerate the Work and bring Subcontractor's performance into compliance with the Project Schedule, (3) require Subcontractor to provide reasonable assurances of timely performance in accordance with the Project Schedule, (4) terminate this Subcontract pursuant to Article X, and/ or (5) exercise all other rights and remedies available under this Subcontract. Subcontractor shall not be entitled to an adjustment in the Subcontract Price or the Subcontract Time as a result of any such action by Contractor.

1.07 ARTICLE V

- A. Changes and Modifications to Subcontract. Without invalidating the Subcontract and without notice to any surety, Contractor may, at any time or from time to time, order additions, deletions or revisions in the Work or acceleration of the Work. Any such additions, deletions, revisions, or acceleration shall be binding upon Contractor and Subcontractor exclusively when made in writing executed by James Gramoll. Upon receipt of such an order, Subcontractor shall promptly proceed with the Work involved, which shall be performed under the applicable conditions of this Subcontract and the Subcontract Documents, except as otherwise specifically provided. Subcontractor shall not proceed to perform changes in the Work without prior written authorization from Contractor as provided herein. Subcontractor shall not be entitled to an adjustment in the Subcontract Price or the Subcontract Time for any work performed without such prior written authorization. Except as provided in this Article V or Section 12.1, the terms and conditions of this Subcontract are not otherwise subject to addition, modification, or change.
- B. Claims. The Subcontract Price and the Subcontract Time may be changed only by a written directive by Contractor, change order, or written Amendment to this Subcontract signed by James Gramoll. Within seven
- C. (7) working days of an occurrence or event giving rise to a claim for an adjustment in the Subcontract Price or Subcontract Time, Subcontractor shall provide to Contractor written notice (hereinafter, a "Claim") stating the nature of the Claim and the adjustment in Subcontract Price and Subcontract Time requested, accompanied by supporting documentation. All Claims shall include and/ or be accompanied by the following supporting information and/ or documents: (a) the specific amount of the requested adjustment in the Subcontract Price, if any, (b) the specific number of days' adjustment in the Subcontract Time requested, if any, (c) the reasons justifying the request for an adjustment in the Subcontract Price and the Subcontract Time, including a CPM analysis demonstrating a critical path delay for any requested adjustment in the Subcontract Time, if any, (d) the party or parties whose orders, decisions, acts or omissions give rise to the requested adjustment in the Subcontract Price and/ or the Subcontract Time,

- and (e) a revised schedule based on the requested adjustments in the Subcontract Time, if any.
- D. A Claim shall be deemed to include all adjustments in Subcontract Price and/ or Subcontract Time to which the claimant is entitled as a result of the occurrence or events giving rise to the Claim. No Claim by Subcontractor for an adjustment of the Subcontract Price or Subcontract Time will be valid if not delivered to the Contractor within the seven (7) working day period prescribed above. Subject to Contractor's right to terminate Subcontractor's rights under this Subcontract, Subcontractor shall continue performance of its obligations under this Subcontract notwithstanding any dispute between Contractor and Subcontractor concerning a Claim asserted by either party.
- E. Subcontractor's sole and exclusive right to an adjustment in the Subcontract Price and/ or the Subcontract Time shall be the adjustment in the contract price and/ or the contract time to the General Contract actually received by Contractor from Owner on behalf of Subcontractor as a result of any such Claim. Subcontractor shall not be entitled to any adjustment in the Subcontract Price or the Subcontract Time or any other remedy under this Subcontract or remedy for breach thereof as a result of any event, occurrence, or act or omission of Contractor or Owner beyond such adjustment in the contract price and/or the contract time to the General Contract received by Contractor from Owner. Receipt by Contractor of a fully-executed written change order from Owner is a condition precedent to Subcontractor's right, if any, to an adjustment in the Subcontract Price and/ or the Subcontract Time, a remedy under this Subcontract, or remedy for breach of this Subcontract. Subcontractor's right to recover for such change, remedy, or breach shall be limited to the adjustment in contract price and/ or contract time received by Contractor from Owner for such change, remedy, or breach.
- F. Delays If events, occurrences, acts, or omissions beyond the control of Subcontractor including, without limitation, the work of other trades or contractors, fire, earthquake, acts of God, terrorist acts, riots, war, strikes or other force majeure events delay Subcontractor's Work, the Subcontract Time and/ or the Subcontract Price will be adjusted to the extent of any adjustment in the contract price and/ or the contract time in the General Contract received by Contractor from Owner on behalf of Subcontractor. Subcontractor may make a Claim for an adjustment in the Subcontract Time and/ or the Subcontract Price if, and only if, Subcontractor timely presents to Contractor a Claim in compliance with Section 5.2. Any such adjustment in the contract price and/ or the contract time under the General Contract received by Contractor from Owner shall be Subcontractor's sole and exclusive remedy for such delays, if any, to Subcontractor's Work on the Project. Receipt by Contractor of a fully executed written change order from Owner is a condition precedent to Subcontractor's right, if any, to an adjustment in the Subcontract Price and/ or the Subcontract Time for delays of any kind or nature.
- G. The Subcontract Time and the Subcontract Price shall not be adjusted and Subcontractor shall not be entitled to any remedy under this Subcontract, or for breach of this Subcontract for (a) delays caused concurrently by Subcontractor and Contractor, Owner or any other person, or (b) any other delays to Subcontractor's Work on the Project for any other events, occurrences, acts or omissions of any person or entity or of any other kind or nature other than that for which an adjustment in the Subcontract Price and/ or the Subcontract Time are expressly authorized in this Section.
- H. Subcontractor-Caused Delays. Subcontractor recognizes and acknowledges that Contractor will suffer substantial Losses if Subcontractor fails to perform the Work in compliance with the Project Schedule. Subcontractor shall indemnify and hold Contractor harmless from and against any and all Losses and liquidated damages that are attributable to or caused by Subcontractor's failure to perform the Work in compliance with the Project Schedule. In addition to liquidated damages, such Losses may include, without limitation, direct jobsite overhead costs such as costs for project management and supervision, quality control, utilities, and other costs such as home office overhead, attorneys' and other professional fees, and other usual and customary mark-ups. If Contractor incurs Losses and/ or is assessed liquidated damages as a result of delays caused concurrently by Subcontractor and other trades or contractors, such Losses and/ or liquidated damages shall be pro rated by Contractor, in its sole discretion, between Subcontractor and all other responsible parties. Contractor's allowing Subcontractor to proceed with Work beyond the time specified for Subcontractor's performance of that Work

shall not constitute a waiver of any rights by Contractor to recover damages for Subcontractor's delay.

1.08 ARTICLE VI

- A. **Payment.** Contractor shall pay Subcontractor in monthly payments of 95% percent of the work performed in any preceding month, in accordance with estimates prepared by Subcontractor. All such pay estimates shall be made on the sample form provided, entitled "Subcontractor's Application for Payment." Contractor has the unfettered right, at its discretion, to adjust Subcontractor's statements to reflect any overestimation of the percent of work complete made by Subcontractor in a pay estimate.
- B. **Pay-If-Paid.** When such pay estimates are approved by Contractor and/ or the Owner, Contractor will pay Subcontractor as payments are received by Contractor from the Owner covering the monthly pay estimates of the Contractor, including the approved portion of Subcontractor's monthly pay estimate.
- C. All payments to Subcontractor will be made only from a special fund, namely, from payments made by Owner to Contractor in respect of work performed by Subcontractor. No payments will be made to Subcontractor
- D. unless that fund comes into existence. Owner's payment to Contractor for Subcontractor's Work is an express condition precedent to Contractor's obligation to make any payment to Subcontractor.
- E. **Delayed Pay Estimate/ Retainage.** If the Subcontractor fails to submit a timely request for payment in an amount approved by Contractor, Subcontractor's payment may be delayed. Contractor shall have the right to withhold from any payment the percentage of retention set forth in the General Contract between Contractor and the Owner, but in no case less than five percent of all amounts due Subcontractor until the project is fully completed and accepted by the architect or Owner, and Contractor has received final payment from the Owner.
- F. **Payroll Summaries/ Prevailing Wages.** Subcontractor agrees to furnish to Contractor one copy of each weekly payroll summary within seven days after the date of payment. Subcontractor agrees to comply with any and all provisions in the General Contract relating to labor standards, minimum wages and other wage and hour provisions to the same extent as they are binding upon Contractor. In the event the Owner requires Contractor to furnish payroll affidavits, subcontractor agrees to furnish similar affidavits to the Contractor.
- G. **Withholding.** Contractor may withhold payment to Subcontractor in whole or in part to the extent necessary, in Contractor's sole discretion, to protect Contractor against Losses for which Subcontractor is responsible as a result of any Default, as that term is defined below.
- H. If, at any time prior to final payment, Contractor determines, in its sole discretion, that it is insecure regarding Subcontractor's ability, willingness, or intent to fulfill its warranty obligations under the Subcontract Documents, Contractor may, at its option, withhold final payment during the entire Warranty Period. Subcontractor waives any right to recover interest on the amount withheld during that time. Contractor shall make final payment for Subcontractor's Work within ten (10) days of (1) expiration of the Warranty Period, or (2) Contractor's receipt of adequate assurances from Subcontractor of its ability, willingness and intent to perform the warranty work, subject to receipt of by Contractor of final payment from Owner as provided in Section 6.2.
- I. **Backcharges.** Where feasible, Contractor shall use reasonable efforts to give Subcontractor notice before any costs are incurred which will be offset against the Subcontract Price. If Subcontractor disagrees with the nature or amount of costs to be incurred, it shall advise Contractor promptly in writing, and in no event later than three (3) days after its receipt of notice from Contractor. Such notification shall include reasons for Subcontractor's dispute and shall propose a reasonable and acceptable alternative along with an estimate of the cost of the alternative, where applicable.
- J. If Contractor receives no protest to a proposed backcharge or Subcontractor protests and does not provide an alternative to Contractor's proposed action, Contractor may proceed to incur the costs and offset them against the Subcontract Price. Costs so offset shall be deemed to be

reasonable and beyond dispute by Subcontractor. If Subcontractor timely protests and proposes a reasonable alternative that Contractor rejects, the disputed costs incurred shall be subject to the dispute resolution procedure outlined in Article XI, if Subcontractor gives Contractor written notice within ten (10) days of such rejection.

- K. Lien Waivers. Subcontractor shall present to Contractor lien waivers for all labor, materials and equipment furnished by others in connection with this Subcontract prior to receiving each payment hereunder. Contractor may require such lien waivers as a condition of progress or final payment.
- L. Liens. Subcontractor shall timely pay all claims for labor, materials, and equipment incurred in the performance of the Work and shall (1) keep the property on which the Project is situated (the "Property") free from mechanic's liens or attachments, and (2) prevent the filing of any claim or stop notice against funds or the payment of funds owed to Contractor, by any person or entity performing a portion of the Work. If any mechanic's lien, attachment, claim against funds, or stop notice is filed against the Property or funds owed to Contractor arising out of or related to performance of the Work, Subcontractor shall, within ten (10) days after written demand by Contractor, take all reasonable steps necessary to cause the effect of such lien, attachment, claim, or stop notice to be released. Upon request by Contractor, Subcontractor shall obtain a lien release or discharge bond or other bond satisfactory to Contractor in the amount of 150% all liens, attachments, claims, or stop notices so recorded or served.
- M. Acceptance of, or payment for, Subcontractor's defective or late work shall not constitute a waiver of any claim or offset that Contractor may have under the terms of this Subcontract.

1.09 ARTICLE VII

- A. Indemnification. To the fullest extent allowed by law, Subcontractor shall indemnify and hold harmless Contractor, Owner, the project architects and engineers, and all of their respective agents and employees (the "Indemnitees") from and against all claims, damages, losses and expenses including, without limitation, attorney's fees ("Losses"), arising out of or resulting from (1) any Default, or failure by Subcontractor to comply with any express duty, warranty, representation, acknowledgment or covenant in this Subcontract, (2) any charges, claims, or liquidated damages assessed and collected by the Owner against Contractor as a result of and to the extent caused by any act or omission of Subcontractor or its sub-subcontractors, guests or invitees; (3) personal or bodily injury to or death of any person, including, without limitation, any agent, employee, guest or invitee of Subcontractor or its sub-subcontractors, other contractors, Contractor, or Owner, to the extent caused by any act or omission of Subcontractor or its sub-subcontractors, guests or invitees, regardless of whether or not they are caused in part by a party indemnified hereunder, (4) damage to or loss of property to the extent caused by any act or omission of Subcontractor or its sub-subcontractors, guests or invitees, regardless of whether or not they are caused in part by a party indemnified hereunder, (5) any use of Contractor's equipment, tools, rigging, blocking, hoists, or scaffolding, (6) liens, attachments, claims, or stop notices against funds or payments owed to Contractor, recorded or served by any of Subcontractor's sub-subcontractors, or (7) infringement of any patent or copyright by Subcontractor. Such obligation shall not be construed to negate, abridge, or otherwise reduce any other right or obligation of indemnity which would otherwise exist as to any party or person described in this paragraph.
- B. The indemnity agreement shall be covered by Subcontractor's comprehensive general liability insurance policy. The indemnity obligations set forth in this Subcontract shall not be limited by (1) the Subcontract Price, or (2) the amount or type of proceeds, compensation, or benefits available to Subcontractor under any insurance policy including, without limitation, any self-insurance or similar program or policy maintained by Subcontractor.
- C. At the request of an Indemnitee, Subcontractor shall defend any claim for Losses against an Indemnitee. The Indemnitee shall be entitled to approve the legal counsel to be paid for by Subcontractor for the purpose of defending such claims for Losses. No claim for Losses shall be settled or discontinued, nor shall judgment be permitted to be entered without the written consent of the Indemnitee, which consent shall not be unreasonably withheld.

1.10 ARTICLE VIII

- A. Insurance. Unless otherwise specified in the Subcontract Documents indicating that insurance shall be provided pursuant to an owner-controlled or contractor-controlled insurance program, Subcontractor shall purchase and maintain the following insurance coverages for itself and the Additional Insureds during the course of the Work and during the Warranty Period, and shall maintain completed operations coverage for itself and the Additional Insureds for the length of time necessary to cover any manifestation date within the applicable statutes of limitations and/or repose which pertain to the Work. If additional insurance coverage or greater limits of liability are required by the General Contract Documents, such provisions shall control.
- B. The liability insurance policies, including commercial general liability, automobile liability and excess liability, shall be endorsed to provide: (1) that Contractor and Owner are additional insureds (the "Additional Insureds") per ISO form CG 20 10 07 04 and CG 20 37 07 04 or their equivalent, (2) that the insurance afforded by the policies shall apply to Contractor as though a separate policy had been issued to Contractor, and (3) that the coverage afforded to Contractor is primary and any other insurance in force for Contractor will be excess and will not contribute to the primary policies. All required insurance shall be provided by insurance companies with a rating of A- VII or better by A.M. Best Company.
- C. Prior to performing any Work, Subcontractor shall provide Contractor with a certificate of insurance demonstrating that Subcontractor has obtained all of the insurance coverages required by this Section. An additional insured endorsement shall be attached to such certificate of insurance. The certificate of insurance and the insurance policies effectuating coverages required by this Section shall contain a provision that coverage afforded under the policies will not be canceled or allowed to expire until at least 30 days prior written notice has been given to Contractor.
- D. Subcontractor waives all rights against Contractor, Owner and Architect and their respective agents, officers, directors and employees for recovery of damages to the extent these damages are covered by commercial general liability, commercial umbrella liability, business auto liability or workers compensation or employers liability insurance.
- E. Subcontractor will protect the job site, the work of Contractor and subcontractors, and its own work until completion and acceptance of the entire project. Contractor and Subcontractor waive all rights against each other and against all other subcontractors and Owner for loss or damage to the extent reimbursed by Builder's Risk or any other property or equipment insurance applicable to the work, except such rights as they may have to the proceeds of such insurance. If the Subcontractors policies of insurance referred to in this Section require an endorsement or consent of the insurance company to provide for continued coverage where there is a waiver of subrogation, the owners of such policies will cause them to be so endorsed or obtain such consent.
- F. Upon written request of the Subcontractor, Contractor shall provide Subcontractor with a copy of the Builder's Risk policy of insurance or any other property or equipment coverage in force for the project and procured by
- G. Contractor. Subcontractor shall satisfy himself as to the existence and extent of such coverage prior to commencement of Subcontractor's work.
- H. If Builder's Risk insurance purchased by Owner or Contractor provides coverage for Subcontractor for loss or damage to Subcontractor's work, Subcontractor shall be responsible for the insurance policy deductible amount applicable to damage to the Subcontractor's work and/or damage to other work caused by Subcontractor. If not covered under the Builder's Risk policy of insurance or any other property or equipment insurance required by the Contract Documents, Subcontractor shall procure and maintain at his own expense property and equipment insurance for portions of Subcontractor's work stored off the site or in transit.
- I. If Owner or Contractor has not purchased Builder's Risk or equivalent insurance including the full insurable value of Subcontractor's work, then Subcontractor may procure such insurance at his own expense as will protect the interests of Subcontractor, and his subcontractors in the work. Such insurance shall also apply to any of the Owner's or Contractor's property in the care, custody, or control of Subcontractor.

- J. Health Insurance Certification. Subcontractor hereby certifies that the Subcontractor and all applicable subcontractors and suppliers at any tier that is subject to UCA 63A-5-205 and Utah Administrative Code Rule R23-23, has and will maintain for the duration of this contract, an offer of qualified health insurance coverage for their employees; all in accordance with UCA 63A-5-205, and Utah Administrative Code Rule R23-23.

1.11 ARTICLE IX

- A. Default. The following acts or omissions by Subcontractor shall constitute events of default ("Default") under this Subcontract and shall give rise to all rights and remedies for material breach of this Subcontract, including, without limitation, termination of this Subcontract:
- B. Notice of Default. Upon written notice of Default, Subcontractor shall, within forty-eight (48) hours of receipt of such notice, take all actions requested by Contractor and such other actions as may be necessary to cure such Default. Subcontractor shall not be entitled to any adjustment in the Subcontract Price or the Subcontract Time as a result of any efforts to cure such Default.
- C. If Subcontractor fails to cure any Default within forty-eight (48) hours after receipt of written notice of Default, Contractor may cure or remedy any Default by Subcontractor. Subcontractor shall reimburse Contractor and/or Contractor may backcharge Subcontractor for, any and all Losses it incurs, plus a reasonable allowance for profit, to cure or remedy any Default, or as a result of any other failure of Subcontractor to comply with the terms and conditions of this Subcontract or the Subcontract Documents. Contractor may offset against the Subcontract Price any Losses incurred as a result of a Default or any amounts owed to Contractor pursuant to this Section.

1.12 ARTICLE X

- A. Termination for Cause. If (1) Subcontractor fails to cure any Default within forty-eight (48) hours after receipt of written notification of such Default, or (2) a Default threatens to cause immediate personal or bodily injury or death, Contractor may terminate Subcontractor's rights under this Subcontract in its entirety and Contractor shall have all the rights and remedies available under this Subcontract and at law or in equity including, without limitation, those remedies specified below.
- B. If Contractor terminates this Subcontract for cause as provided herein, Contractor may, without prejudice to any other of its rights or remedies, perform and complete the Work and in connection therewith, Contractor may do any or all of the following:
- C. Upon termination for cause as provided herein, Subcontractor shall not be entitled to receive any further payment until completion of all of the Work and acceptance of the entire Project. Subcontractor shall reimburse Contractor for all Losses it incurs to complete Subcontractor's Work, plus a reasonable allowance for overhead
- D. and profit. If the unpaid balance of the Subcontract Price exceeds the Contractor's Losses, plus allowance for overhead and profit, Contractor shall pay such excess to Subcontractor. If such Losses, overhead, and profit exceed the unpaid balance of the Subcontract Price, the Subcontractor shall pay the difference to Contractor. In addition, Contractor shall be entitled to such other and further remedies available at law or in equity.
- E. Suspension for Convenience. Contractor may, without cause, suspend, delay or interrupt the Work in whole or in part for such period of time as the Contractor may determine and/ or as provided in the Subcontract Documents. Subject to the requirements and limitations of Article V, the Subcontract Price and Subcontract Time may be adjusted for increases in the cost and time to complete the Work caused by such suspension. No adjustment shall be made, however, to the extent that (a) performance is, was or would have been so suspended, delayed or interrupted by another cause for which the Subcontractor is responsible, (b) an adjustment is made or denied under another provision of this Subcontract, or (c) Contractor is not entitled to an adjustment in the contract price and/ or the contract time under the General Contract on behalf of Subcontractor as a result of such suspension.
- F. Termination for Convenience. The Contractor may, at any time, terminate this Subcontract for the convenience of Contractor and without cause. Subcontractor's sole and exclusive right to

compensation for Losses resulting from such termination shall be the compensation actually received by Contractor from Owner on behalf of Subcontractor as a result of any such termination. Subcontractor shall not be entitled to any compensation for Losses or any other remedy under this Subcontract or for breach thereof as a result of such termination beyond such adjustment in the contract price and/ or the contract price to the Prime Contract received by Contractor from Owner on behalf of Subcontractor. Receipt by Contractor of such compensation is a condition precedent to Subcontractor's right, if any, to compensation for Losses resulting from such termination. Subcontractor's right to recover for such termination shall be limited to the compensation received by Contractor from Owner for such termination on behalf of Subcontractor.

1.13 ARTICLE XI

- A. Dispute Resolution. Disputes, if any, between Subcontractor and Contractor arising out of or relating to this Subcontract or the Work shall be resolved as provided in this Article.
- B. Disputes Involving the Owner or the Architect. Any disputes in which the Owner or the Architect is a party shall be governed by the dispute resolution procedures in the Subcontract Documents other than this Subcontract. If those Subcontract Documents contain no dispute resolution procedures, such disputes shall be resolved as provided in Section 11.3 below.
- C. Disputes Not Involving the Owner or the Architect. At the sole and exclusive discretion of Contractor, all disputes in which neither the Owner nor the Architect is a party shall be resolved in (1) binding arbitration, or (2) litigation in a state or federal court of competent jurisdiction situated in the state of the location of the Project. If Contractor determines to resolve disputes under this Subcontract by binding arbitration, the following rules shall apply.

1.14 ARTICLE XII

- A. This Subcontract and the Subcontract Documents constitute the final, complete, and exclusive statement of the agreement between the parties, and supersedes and replaces in their entirety all prior oral or written agreements, including but not limited to, bids and bid acceptances. This Subcontract may not be altered, amended or extended, except by written agreement of the parties hereto executed by James Gramoll on behalf of Contractor.
- B. This Subcontract shall inure to the benefit of and be binding upon the parties hereto, their successors and permitted assigns.
- C. Delay by Contractor in enforcing any rights or remedies in the event of Default or a breach of any term or condition of this Subcontract or any other contract between Contractor or Subcontractor, shall not be construed as a waiver of such Default or breach. Payment by Contractor of progress payments or final payment shall not be construed as acceptance of any work for which payment is made or waiver of any Claims, rights, or remedies under this Subcontract.
- D. This Subcontract shall be construed and interpreted as a whole in accordance with its fair meaning and in accordance with the laws of the state of the location of the Project. Under no circumstances, however, shall such laws be interpreted to apply conflict of laws principles to require the laws of another state to determine the interpretation or construction of this Subcontract.
- E. Performance Guaranty. If Subcontractor operates as a corporation, limited liability company, partnership or a business entity other than as an individual or sole proprietor, this Subcontract will be signed by the President and Secretary of the corporation, the managing member(s), partners, or other authorized principals of Subcontractor's company, and the officers, managing member(s), partners, and/ or other principals signing this Subcontract on behalf of the corporation, limited liability company, partnership or other business entity do jointly and severally, guarantee to the Contractor the full and faithful performance of this Subcontract by Subcontractor, and do further agree, jointly and severally, that they shall be personally liable to Contractor for the full and faithful performance of Subcontractor's obligations under this Subcontract. Failure of Contractor to request a performance bond from Subcontractor shall not affect the obligation assumed by the officers, managing members, partners or other principals signing this Subcontract on behalf of Subcontractor.

**1.15 IN WITNESS WHEREOF, THIS SUBCONTRACT HAS BEEN EXECUTED BY THE
CONTRACTOR AND SUBCONTRACTOR AS OF THE DAY AND THE YEAR BELOW.**

1.16 SUBCONTRACTOR: GREEN CONSTRUCTION, INC.

CONTRACTOR: GRAMOLL CONSTRUCTION COMPANY

END OF SECTION 005201

SECTION 011000 SUMMARY

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Project information.
 - 2. Work covered by Contract Documents.
 - 3. Phased construction.
 - 4. Work performed by Owner.
 - 5. Multiple Work Packages.
 - 6. Work under Owner's separate contracts.
 - 7. Future work not part of this Project.
 - 8. Owner's product purchase contracts.
 - 9. Owner-furnished/Contractor-installed (OFCI) products.
 - 10. Owner-furnished/Owner-installed (OFOI) products.
 - 11. Contractor-furnished/Owner-installed (CFOI) products.
 - 12. Contractor's use of site and premises.
 - 13. Coordination with occupants.
 - 14. Work restrictions.
 - 15. Specification and Drawing conventions.
 - 16. Miscellaneous provisions.
- B. Related Requirements:
 - 1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.03 DEFINITIONS

- A. Work Package: A group of specifications, drawings, and schedules prepared by the design team to describe a portion of the Project Work for pricing, permitting, and construction.

1.04 PROJECT INFORMATION

- A. Project Identification: Rio Grande Depot Seismic Retrofit, DFCM # 20229080.
 - 1. Phase 1: Design Development Demolition Bid Package 1
 - 2. Project Location: 270 South Rio Grande Street, Salt Lake City, UT 84101.
- B. Owner: State of Utah.
 - 1. Owner's Representative: Ashley J Greenwood, DFCM, Project Manager, 385-522-9196, ajgreenwood@utah.gov.
- C. Architect: CRSA, 175 South Main Street, ste #300, Salt Lake City, UT 84111, 801-355-5915.
 - 1. Architect's Representative: Zach Heslop, 801-746-6820, john@crsa-us.com, Kenneth E Wheadon, 801-746-4979, ken@crsa-us.com.
- D. Architect's Consultants: Architect has retained the following design professionals, who have prepared designated portions of the Contract Documents:
 - 1. Consulting Preservation Architect:
 - a. Representative: John Ewanowski, 1-608-333-2133, ewanowski@gmail.com.
 - 2. Structural Engineer: Reaveley Engineering.
 - a. Representative: Austin Guter, 801-4863892, aguter@reaveley.com.
 - 3. Mechanical Engineer: Colvin Engineers.
 - a. Representative: Steve Connor, 801-322-2400, sconnor@cea-ut.com
 - 4. Electrical Engineer: Spectrum Engineers.
 - a. Representative: Michael C. Fackrell, 801-401-8447, mcf@spectrum-engineers.com.

5. Interior Design: CRSA.
 - a. Representative: Elaine Jones, 801-746-6831, elaine@crsa-us.com .
- E. Other Owner Consultants: Owner has retained the following design professionals who have prepared designated portions of the Contract Documents:
- F. Web-Based Project Software: Project software will be used for purposes of managing communication and documents during the construction stage.
 1. See Section 013100 "Project Management and Coordination." for requirements for using web-based Project software.

1.05 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and includes, but is not limited to, the following:
 1. Scope of this bid package contains the salvage and storage of historic materials and items. Selective demolition for ease of access for work to be performed by owner's consultant and other Work indicated in the Contract Documents.
- B. Type of Contract:
 1. Project will be constructed under a single prime contract.

1.06 WORK PERFORMED BY OWNER

- A. Cooperate fully with Owner, so work may be carried out smoothly, without interfering with or delaying Work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.
- B. Preceding Work: Owner will perform the following construction operations at Project site. Those operations are scheduled to be substantially complete before Work under this Contract begins.
 1. Relocate exterior miscellaneous items within the contract limit line.
- C. Subsequent Work: Owner will perform the following additional work at site after Substantial Completion. Completion of that work will depend on successful completion of preparatory Work under this Contract.
 1. n/a.

1.07 OWNER'S PRODUCT PURCHASE CONTRACTS

- A. Owner has negotiated Product Purchase contracts with suppliers of material and equipment to be incorporated into the Work. Owner will assign these Product Purchase contracts to Contractor. Include costs for purchasing, receiving, handling, storage if required, and installation of material and equipment in the Contract Sum unless otherwise indicated.
 1. Contractor's responsibilities are same as if Contractor had negotiated Product Purchase contracts, including responsibility to renegotiate purchase and to execute final purchasing agreements.

1.08 OWNER-FURNISHED/CONTRACTOR-INSTALLED (OFCI) PRODUCTS

- A. Owner's Responsibilities: Owner will furnish products indicated and perform the following, as applicable:
 1. Provide to Contractor Owner-reviewed Product Data, Shop Drawings, and Samples.
 2. Provide for delivery of Owner-furnished products to Project site.
 3. Upon delivery, inspect, with Contractor present, delivered items.
 - a. If Owner-furnished products are damaged, defective, or missing, arrange for replacement.
 4. Obtain manufacturer's inspections, service, and warranties.
 5. Inform Contractor of earliest available delivery date for Owner-furnished products.
- B. Contractor's Responsibilities: The Work includes the following, as applicable:
 1. Designate delivery dates of Owner-furnished products in Contractor's construction schedule, utilizing Owner-furnished earliest available delivery dates.
 2. Review Owner-reviewed Product Data, Shop Drawings, and Samples, noting discrepancies and other issues in providing for Owner-furnished products in the Work.
 3. Receive, unload, handle, store, protect, and install Owner-furnished products.

4. Make building services connections for Owner-furnished products.
 5. Protect Owner-furnished products from damage during storage, handling, and installation and prior to Substantial Completion.
 6. Repair or replace Owner-furnished products damaged following receipt.
- C. Owner-Furnished/Contractor-Installed (OFCl) Products:
1. n/a.

1.09 OWNER-FURNISHED/OWNER-INSTALLED (OFOI) PRODUCTS

- A. The Owner will furnish and install products indicated.
- B. Owner-Furnished/Owner-Installed (OFOI) Products:
1. n/a.

1.10 CONTRACTOR-FURNISHED/OWNER-INSTALLED (CFOI) PRODUCTS

- A. Contractor shall furnish products indicated. The Work includes unloading, handling, storing, and protecting Contractor-furnished products as directed and turning them over to Owner at Project closeout.
- B. Contractor-Furnished/Owner-Installed (CFOI) Products:
1. N/A.

1.11 CONTRACTOR'S USE OF SITE AND PREMISES

- A. Unrestricted Use of Site: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.
- B. Limits on Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
1. Limits on Use of Site: Confine construction operations to access drive and immediate area around the carriage house.
 2. Driveways, Walkways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.
- D. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.12 COORDINATION WITH OCCUPANTS

- A. Owner does occupy parts of the building currently for the removal of archived items. Coordinate with facility manager, representative of the Department of Cultural & Community Engagement and representative of the State Archives.

1.13 WORK RESTRICTIONS

- A. Comply with restrictions on construction operations.
1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work to between 7:00 a.m. to 7:00 p.m., Monday through Friday, unless otherwise indicated. Work hours may be modified to meet Project requirements if approved by Owner and authorities having jurisdiction.
1. Weekend Hours: Same as weekday unless the grounds are occupied by other activities.

2. Early Morning Hours: Reference DFCM for regulations by authorities having jurisdiction for restrictions on noisy work.
 3. Work in Existing Building: Same as weekday or weekend hours.
 4. Hours for Utility Shutdowns: No restrictions, notify owner prior to shutdowns 24 hours prior to implementation.
 5. Hours for Core Drilling 7:00 a.m. to 7:00 p.m. .
- C. On-Site Work Day Restrictions: Do not perform work resulting in utility shutdowns or resulting in noisy activity on-site during work black-out days indicated in Document 003113 "Preliminary Schedules."
- D. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging for temporary utility services according to requirements indicated:
1. Notify Architect and Owner not less than two days in advance of proposed utility interruptions.
 2. Obtain Owner's written permission before proceeding with utility interruptions.
- E. Noise, Vibration, Dust, and Odors: Coordinate operations that may result in high levels of noise and vibration, dust, odors, or other disruption to Owner occupancy with Owner.
1. Notify Architect and Owner not less than two days in advance of proposed disruptive operations.
 2. Obtain Owner's written permission before proceeding with disruptive operations.
- F. Smoking and Controlled Substance Restrictions: Use of tobacco products, alcoholic beverages, and other controlled substances within the existing building and on Project site is not permitted.
- G. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.
- H. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project site.
1. Maintain list of approved screened personnel with Owner's representative.

1.14 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 2. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
 3. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.
 4. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 00 Contracting Requirements: General provisions of the Contract, including General and Supplementary Conditions, apply to all Sections of the Specifications.
- C. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- D. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.

2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings.
3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 011000

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**SECTION 012500
SUBSTITUTION PROCEDURES**

EXECUTED AS PART OF BID PACKAGE 01

PART 1 GENERAL

2.01 SECTION INCLUDES

- A. Procedural requirements for proposed substitutions.

2.02 DEFINITIONS

- A. Substitutions: Changes from Contract Documents requirements proposed by Contractor to materials, products, assemblies, and equipment.
 - 1. Substitutions for Cause: Proposed due to changed Project circumstances beyond Contractor's control.
 - a. Unavailability.
 - 2. Substitutions for Convenience: Proposed due to possibility of offering substantial advantage to the Project.
 - a. Substitution requests offering advantages solely to the Contractor will not be considered.

2.03 REFERENCE STANDARDS

- A. CSI/CSC Form 1.5C - Substitution Request (During the Bidding/Negotiating Stage) Current Edition.
- B. CSI/CSC Form 13.1A - Substitution Request (After the Bidding/Negotiating Phase) Current Edition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

4.01 GENERAL REQUIREMENTS

- A. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:
 - 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
 - 2. Agrees to provide the same warranty for the substitution as for the specified product.
 - 3. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
 - 4. Waives claims for additional costs or time extension that may subsequently become apparent.
- B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.
- C. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.
 - 1. Forms indicated in the Project Manual are adequate for this purpose, and must be used.
- D. Limit each request to a single proposed substitution item.

4.02 SUBSTITUTION PROCEDURES DURING PROCUREMENT

- A. Submittal Time Restrictions:
 - 1. Owner will consider requests for substitutions only if submitted at least 10 days prior to the date for receipt of bids.
- B. Submittal Form (before award of contract):
 - 1. Submit substitution requests by completing CSI/CSC Form 1.5C - Substitution Request. See this form for additional information and instructions. Use only this form; other forms of submission are unacceptable.

4.03 SUBSTITUTION PROCEDURES DURING CONSTRUCTION

- A. Submittal Form (after award of contract):
 - 1. Submit substitution requests by completing CSI/CSC Form 13.1A - Substitution Request (After Bidding/Negotiating). See this form for additional information and instructions. Use only this form; other forms of submission are unacceptable.
- B. Architect will consider requests for substitutions only within 15 days after date of Agreement.
- C. Submit request for Substitution for Cause within 14 days of discovery of need for substitution, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.
- D. Submit request for Substitution for Convenience immediately upon discovery of its potential advantage to the project, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.
 - 1. In addition to meeting general documentation requirements, document how the requested substitution benefits the Owner through cost savings, time savings, greater energy conservation, or in other specific ways.
 - 2. Document means of coordinating of substitution item with other portions of the work, including work by affected subcontractors.
 - 3. Bear the costs engendered by proposed substitution of:
 - a. Owner's compensation to the Architect for any required redesign, time spent processing and evaluating the request.
- E. Substitutions will not be considered under one or more of the following circumstances:
 - 1. When they are indicated or implied on shop drawing or product data submittals, without having received prior approval.
 - 2. When acceptance will require revisions to Contract Documents.

4.04 RESOLUTION

4.05 ACCEPTANCE

4.06 CLOSEOUT ACTIVITIES

END OF SECTION 012500

**SECTION 013000
ADMINISTRATIVE REQUIREMENTS**

ADDENDUM #01 OCT 19, 2022

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General administrative requirements.
- B. Electronic document submittal service.
- C. Preconstruction meeting.
- D. Coordination drawings.
- E. Submittals for review, information, and project closeout.
- F. Number of copies of submittals.
- G. Requests for Interpretation (RFI) procedures.
- H. Submittal procedures.

1.02 RELATED REQUIREMENTS

- A. Owner provided General and Supplementary Conditions.

1.03 PROJECT COORDINATOR

- A. Project Coordinator: Construction Manager.
- B. Cooperate with the Project Coordinator in allocation of mobilization areas of site; for field offices and sheds, for _____ access, traffic, and parking facilities.
- C. During construction, coordinate use of site and facilities through the Project Coordinator.
- D. Comply with Project Coordinator's procedures for intra-project communications; submittals, reports and records, schedules, coordination drawings, and recommendations; and resolution of ambiguities and conflicts.
- E. Comply with instructions of the Project Coordinator for use of temporary utilities and construction facilities. Responsibility for providing temporary utilities and construction facilities is identified in Section 011000 - Summary.
- F. Coordinate field engineering and layout work under instructions of the Project Coordinator.
- G. Make the following types of submittals to Architect through the Project Coordinator:
 - 1. Requests for Interpretation.
 - 2. Requests for substitution.
 - 3. Shop drawings, product data, and samples.
 - 4. Manufacturer's instructions and field reports.
 - 5. Applications for payment and change order requests.
 - 6. Progress schedules.
 - 7. Coordination drawings.
 - 8. Correction Punch List and Final Correction Punch List for Substantial Completion.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 ~~ELECTRONIC DOCUMENT SUBMITTAL SERVICE~~

- A. ~~All documents transmitted for purposes of administration of the contract are to be in electronic (PDF, MS Word, or MS Excel) format, as appropriate to the document, and transmitted via an Internet-based submittal service that receives, logs and stores documents, provides electronic stamping and signatures, and notifies addressees via email.~~
- B. ~~Besides submittals for review, information, and closeout, this procedure applies to Requests for Interpretation (RFIs), progress documentation, contract modification documents (e.g. supplementary instructions, change proposals, change orders), applications for payment, field reports and meeting minutes, Contractor's correction punchlist, and any other document any~~

~~participant wishes to make part of the project record.~~

- ~~C. Contractor and Architect are required to use this service.~~
- ~~D. It is Contractor's responsibility to submit documents in allowable format.~~
- ~~E. Subcontractors, suppliers, and Architect's consultants will be permitted to use the service at no extra charge.~~
- ~~F. Users of the service need an email address, internet access, and PDF review software that includes ability to mark up and apply electronic stamps (such as Adobe Acrobat, www.adobe.com, or Bluebeam PDF Revu, www.bluebeam.com), unless such software capability is provided by the service provider.~~
- ~~G. Paper document transmittals will not be reviewed; emailed electronic documents will not be reviewed.~~
- ~~H. All other specified submittal and document transmission procedures apply, except that electronic document requirements do not apply to samples or color selection charts.~~

3.02 SUBMITTAL SERVICE: THE SELECTED SERVICE IS:

3.03 TRAINING: ONE, ONE HOUR, WEB-BASED TRAINING SESSION WILL BE ARRANGED FOR ALL PARTICIPANTS, WITH REPRESENTATIVES OF ARCHITECT AND CONTRACTOR PARTICIPATING; FURTHER TRAINING IS THE RESPONSIBILITY OF THE USER OF THE SERVICE.

3.04 PROJECT CLOSEOUT: ARCHITECT WILL DETERMINE WHEN TO TERMINATE THE SERVICE FOR THE PROJECT AND IS RESPONSIBLE FOR OBTAINING ARCHIVE COPIES OF FILES FOR OWNER.

3.05 PRECONSTRUCTION MEETING

1. Project Coordinator will schedule a meeting after Notice of Award.
2. Attendance Required:
 - a. Owner.
 - b. Architect.
 - c. Contractor.
3. Agenda:
 - a. Execution of Owner-Contractor Agreement.
 - b. Submission of executed bonds and insurance certificates.
 - c. Distribution of Contract Documents.
 - d. Submission of list of subcontractors, list of products, schedule of values, and progress schedule.
 - e. Designation of personnel representing the parties to Contract, _____ and Architect.
 - f. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 - g. Scheduling.
4. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.06 COORDINATION DRAWINGS

3.07 REQUESTS FOR INTERPRETATION (RFI)

1. Definition: A request seeking one of the following:
 - a. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them 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 Contract Documents.
 - b. A resolution to an issue which has arisen due to field conditions and affects design intent.
2. Whenever possible, request clarifications at the next appropriate project progress meeting, with response entered into meeting minutes, rendering unnecessary the

issuance of a formal RFI.

3.08 SUBMITTALS FOR REVIEW

1. When the following are specified in individual sections, submit them for review:
 - a. Product data.
 - b. Shop drawings.
 - c. Samples for selection.
 - d. Samples for verification.
2. Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.
3. Samples will be reviewed for aesthetic, color, or finish selection.
4. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 017800 - Closeout Submittals.

3.09 SUBMITTALS FOR INFORMATION

1. When the following are specified in individual sections, submit them for information:
 - a. Design data.
 - b. Certificates.
 - c. Test reports.
 - d. Inspection reports.
 - e. Manufacturer's instructions.
 - f. Manufacturer's field reports.
 - g. Other types indicated.
2. Submit for Architect's knowledge as contract administrator or for Owner.

3.10 SUBMITTALS FOR PROJECT CLOSEOUT

1. Submit Correction Punch List for Substantial Completion.
2. Submit Final Correction Punch List for Substantial Completion.
3. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 017800 - Closeout Submittals:
 - a. Project record documents.
 - b. Operation and maintenance data.
 - c. Warranties.
 - d. Bonds.
 - e. Other types as indicated.
4. Submit for Owner's benefit during and after project completion.

3.11 NUMBER OF COPIES OF SUBMITTALS

1. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.
2. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.
 - a. After review, produce duplicates.
 - b. Retained samples will not be returned to Contractor unless specifically so stated.

3.12 SUBMITTAL PROCEDURES

1. General Requirements:

END OF SECTION 013000

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**SECTION 013216
CONSTRUCTION PROGRESS SCHEDULE**

EXECUTED AS PART OF BID PACKAGE 01

PART 1 GENERAL

2.01 SECTION INCLUDES

- A. Preliminary schedule.
- B. Construction progress schedule, bar chart type.

2.02 RELATED SECTIONS

- A. Section 011000 - Summary: Work sequence.

2.03 SUBMITTALS

- A. Within 10 days after date of Agreement, submit preliminary schedule.
- B. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
 - 1. Include written certification that major contractors have reviewed and accepted proposed schedule.
- C. Submit updated schedule with each Application for Payment.
- D. Submit in PDF format.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

4.01 PRELIMINARY SCHEDULE

- A. Prepare preliminary schedule in the form of a horizontal bar chart.

4.02 CONTENT

- A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.
- B. Identify each item by specification section number.
- C. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.
- D. Provide legend for symbols and abbreviations used.

4.03 BAR CHARTS

- A. Include a separate bar for each major portion of Work or operation.
- B. Identify the first work day of each week.

4.04 NETWORK ANALYSIS

- A. Prepare network analysis diagrams and supporting mathematical analyses using the Critical Path Method.
- B. Illustrate order and interdependence of activities and sequence of work; how start of a given activity depends on completion of preceding activities, and how completion of the activity may restrain start of subsequent activities.
- C. Mathematical Analysis: Tabulate each activity of detailed network diagrams, using calendar dates, and identify for each activity:
 - 1. Preceding and following event numbers.
 - 2. Activity description.
 - 3. Estimated duration of activity, in maximum 15 day intervals.
 - 4. Earliest start date.
 - 5. Earliest finish date.
 - 6. Actual start date.
 - 7. Actual finish date.

8. Latest start date.
 9. Latest finish date.
 10. Total and free float; float time shall accrue to Owner and to Owner's benefit.
 11. Monetary value of activity, keyed to Schedule of Values.
 12. Percentage of activity completed.
 13. Responsibility.
- D. Analysis Program: Capable of compiling monetary value of completed and partially completed activities, accepting revised completion dates, and recomputation of all dates and float.
- E. Required Reports: List activities in sorts or groups:
1. By preceding work item or event number from lowest to highest.
 2. By amount of float, then in order of early start.

4.05 UPDATING SCHEDULE

- A. Maintain schedules to record actual start and finish dates of completed activities.
- B. Indicate progress of each activity to date of revision, with projected completion date of each activity.
- C. Annotate diagrams to graphically depict current status of Work.
- D. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.
- E. Indicate changes required to maintain Date of Substantial Completion.
- F. Submit reports required to support recommended changes.

4.06 DISTRIBUTION OF SCHEDULE

- A. Distribute copies of updated schedules to Contractor's project site file, to subcontractors, suppliers, Architect, Owner, and other concerned parties.
- B. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

END OF SECTION 013216

**SECTION 013233
PHOTOGRAPHIC DOCUMENTATION**

ADDENDUM #01 OCT 19, 2022

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Concealed Work photographs.
 - 3. Periodic construction photographs.
 - 4. Final Completion construction photographs.
- B. Related Requirements:
 - 1. Section 024119 "Selective Demolition" for photographic documentation before selective demolition operations commence.
 - 2. Section 024296 "Historic Removal and Dismantling" for photographic documentation before building demolition operations commence.

1.03 INFORMATIONAL SUBMITTALS

- A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- B. Digital Photographs: Submit image files within three days of taking photographs.
 - 1. Submit photos by uploading to "Bluebeam Project" ~~web-based Project management software site~~. Include copy of key plan indicating each photograph's location and direction.
 - 2. Identification: Provide the following information with each image description:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date photograph was taken.
 - f. Description of location, vantage point, and direction.
 - g. Unique sequential identifier keyed to accompanying key plan.

1.04 QUALITY ASSURANCE

- A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.

1.05 FORMATS AND MEDIA

- A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels, and with vibration-reduction technology. Use flash in low light levels or backlit conditions.
- B. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
- C. Metadata: Record accurate date and time from camera.
- D. File Names: Name media files with date and sequential numbering suffix.

1.06 CONSTRUCTION PHOTOGRAPHS

- A. Photographer: Engage a qualified photographer (can be contractor superintendent or contractor project manager) to take construction photographs.

- B. General: Take photographs with maximum depth of field and in focus.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- C. Preconstruction Photographs: Before commencement of the Work, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
 - 1. Flag construction limits before taking construction photographs.
 - 2. Take 20 photographs to show existing conditions adjacent to property before starting the Work.
 - 3. Take 20 photographs of existing buildings either on or adjoining property, to accurately record physical conditions at start of construction.
 - 4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- D. Concealed Work Photographs: Before proceeding with installing work that will conceal other work, take photographs sufficient in number, with annotated descriptions, to record nature and location of concealed Work, including, but not limited to, the following:
 - 1. Underground utilities.
 - 2. Underslab services.
 - 3. Piping.
 - 4. Electrical conduit.
 - 5. Waterproofing and weather-resistant barriers.
 - 6. Unforeseen conditions.
- E. Periodic Construction Photographs: Take 20 photographs weekly coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.
- F. Final Completion Construction Photographs: Take 100 photographs after date of Substantial Completion for submission as Project Record Documents. Architect will inform photographer of desired vantage points.
- G. Additional Photographs: Architect may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.
 - 1. Three days' notice will be given, where feasible.
 - 2. In emergency situations, take additional photographs within 24 hours of request.
 - 3. Circumstances that could require additional photographs include, but are not limited to, the following:
 - a. Special events planned at Project site.
 - b. Immediate follow-up when on-site events result in construction damage or losses.
 - c. Photographs shall be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
 - d. Substantial Completion of a major phase or component of the Work.
 - e. Extra record photographs at time of final acceptance.
 - f. Owner's request for special publicity photographs.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 013233

**SECTION 013591
HISTORIC TREATMENT PROCEDURES**

ADDENDUM #01 OCT 19, 2022

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes general protection and treatment procedures for designated historic spaces, areas, rooms, and surfaces in Project.

1.03 DEFINITIONS

- A. Consolidate: To strengthen loose or deteriorated materials in place.
- B. Design Reference Sample: A sample that represents Architect's pre-bid selection of work to be matched; it may be existing work or work specially produced for Project.
- C. Dismantle: To disassemble or detach a historic item from a surface, or a non-historic item from a historic surface, using gentle methods and equipment to prevent damage to historic items and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- D. Historic: Spaces, areas, rooms, surfaces, materials, finishes, and overall appearance that are important to the successful rehabilitation and restoration as determined by Architect. Designated historic spaces, areas, rooms and surfaces are indicated on Drawings.
 - 1. Restoration Zones Grade 1 Areas: Areas of greatest architectural importance, integrity, and visibility; to be preserved and restored to the original, circa 1893, design and finish as indicated on Drawings.
 - 2. Renovation Zones Grade 2 Areas: Areas of significant architectural importance, integrity, and visibility; to be preserved and restored consistent with the remaining historic fabric and to the extent indicated on Drawings.
 - 3. Alteration Zones Grade 3 Areas: Areas of slight architectural importance, integrity, and visibility; to leave any remaining original fabric untouched insofar as is consistent with accommodating modern uses for the building as indicated on Drawings.
- E. Match: To blend with adjacent construction and manifest no apparent difference in material type, species, cut, form, detail, color, grain, texture, or finish; as approved by Architect.
- F. Refinish: To remove existing finishes to base material and apply new finish to match original, or as otherwise indicated.
- G. Reinstall: To protect removed or dismantled item, repair and clean it as indicated for reuse, and reinstall it in original position, or where indicated.
- H. Remove: To take down or detach a non-historic item located within a historic space, area, or room, using methods and equipment to prevent damage to historic items and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- I. Repair: To correct damage and defects, retaining existing materials, features, and finishes while employing as little new material as possible. This includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials.
- J. Replace: To remove, duplicate, and reinstall entire item with new material. The original item is the pattern for creating duplicates unless otherwise indicated.
- K. Replicate: To reproduce in exact detail, materials, and finish unless otherwise indicated.
- L. Reproduce: To fabricate a new item, accurate in detail to the original, and from either the same or a similar material as the original, unless otherwise indicated.
- M. Restore: To consolidate, replicate, reproduce, repair, and refinish as required to achieve the indicated results.
- N. Retain: To keep existing items that are not to be removed or dismantled.

- O. Reversible: New construction work, treatments, or processes that can be removed or undone in the future without damaging historic materials unless otherwise indicated.
- P. Salvage: To protect removed or dismantled items and deliver them to Owner ready for reuse.
- Q. Stabilize: To provide structural reinforcement of unsafe or deteriorated items while maintaining the essential form as it exists at present; also, to reestablish a weather-resistant enclosure.
- R. Strip: To remove existing finish down to base material unless otherwise indicated.

1.04 COORDINATION

- A. Historic Treatment Sub-schedule: A construction schedule coordinating the sequencing and scheduling of historic treatment work for entire Project, including each activity to be performed in historic spaces, areas, and rooms, and on historic surfaces; and based on Contractor's Construction Schedule. Secure time commitments for performing critical construction activities from separate entities responsible for historic treatment work.
 - 1. Schedule construction operations in sequence required to obtain best historic treatment results.
 - 2. Coordinate sequence of historic treatment work activities to accommodate the following:
 - a. Owner's continuing occupancy of portions of existing building.
 - b. Owner's partial occupancy of completed Work.
 - c. Other known work in progress.
 - d. Tests and inspections.
 - 3. Detail sequence of historic treatment work, with start and end dates.
 - 4. Utility Services: Indicate how long utility services will be interrupted. Coordinate shutoff, capping, and continuation of utility services.
 - 5. Use of elevator and stairs.
 - 6. Equipment Data: List gross loaded weight, axle-load distribution, and wheel-base dimension data for mobile and heavy equipment proposed for use. Do not use such equipment without certification from Contractor's professional engineer that the structure can support the imposed loadings without damage.
- ~~B. Pedestrian and Vehicular Circulation: Coordinate historic treatment work with circulation patterns within Project building(s) and site. Some work is near circulation patterns and active Jordan River Trail. Circulation patterns cannot be closed off entirely, and in places can be only temporarily redirected around small areas of work. Plan and execute the Work accordingly.~~

1.05 PROJECT MEETINGS FOR HISTORIC TREATMENT

- A. Preliminary Historic Treatment Conference: Before starting historic treatment work, conduct conference at Project site.
 - 1. Attendees: In addition to representatives of Owner, Architect, and Contractor, testing service representative, historic treatment specialists, chemical-cleaner manufacturer(s), and installers whose work interfaces with or affects historic treatment shall be represented at the meeting.
 - 2. Agenda: Discuss items of significance that could affect progress of historic treatment work, including review of the following:
 - a. Historic Treatment Sub-schedule: Discuss and finalize; verify availability of materials, historic treatment specialists' personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Fire-prevention plan.
 - c. Governing regulations.
 - d. Areas where existing construction is to remain and the required protection.
 - e. Hauling routes.
 - f. Sequence of historic treatment work operations.
 - g. Storage, protection, and accounting for salvaged and specially fabricated items.
 - h. Existing conditions, staging, and structural loading limitations of areas where materials are stored.
 - i. Qualifications of personnel assigned to historic treatment work and assigned duties.
 - j. Requirements for extent and quality of work, tolerances, and required clearances.

- k. Methods and procedures related to historic treatments, including product manufacturers' written instructions and precautions regarding historic treatment procedures and their effects on materials, components, and vegetation.
 - l. Embedded work such as flashings and lintels, special details, collection of wastes, protection of occupants and the public, and condition of other construction that affect the Work or will affect the work.
3. Reporting: Record conference results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from conference.
- B. Coordination Meetings: Conduct specifically for historic treatment work at weekly intervals. Coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
1. Attendees: In addition to representatives of Owner, Architect, and Contractor, each historic treatment specialist, supplier, installer, and other entity concerned with progress or involved in planning, coordination, or performance of historic treatment work activities shall be represented at these meetings. All participants at conference shall be familiar with Project and authorized to conclude matters relating to historic treatment work.
 2. Agenda: Review and correct or approve minutes of previous coordination meeting. Review other items of significance that could affect progress of historic treatment work. Include topics for discussion as appropriate to status of Project.
 - a. Historic Treatment Sub-schedule: Review progress since last coordination meeting. Determine whether each schedule item is on time, ahead of schedule, or behind schedule. Determine how construction behind schedule will be expedited with retention of quality; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities are completed within the Contract Time.
 - b. Schedule Updating: Revise Contractor's Historic Treatment Sub-schedule after each coordination meeting where revisions to schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each entity present, including review items listed in the "Preliminary Historic Treatment Conference" Paragraph in this article and the following:
 - 1) Interface requirements of historic treatment work with other Project Work.
 - 2) Status of submittals for historic treatment work.
 - 3) Access to historic treatment work.
 - 4) Effectiveness of fire-prevention plan.
 - 5) Quality and work standards of historic treatment work.
 - 6) Change Orders for historic treatment work.
 3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.06 MATERIALS OWNERSHIP

- A. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered or uncovered during the Work, regardless of whether they were previously documented, remain Owner's property.
1. Dismantle and salvage each item or object and protect it from damage, then promptly deliver it to Owner where directed.
 2. Coordinate with Owner's historical adviser who will establish special procedures for dismantling and salvaging.

1.07 INFORMATIONAL SUBMITTALS

- A. Historic Treatment Sub-schedule:
1. Submit historic treatment sub-schedule within seven days of date established for commencement of historic treatment work.
- B. Preconstruction Documentation: Show preexisting conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by

Contractor's historic treatment operations.

- C. Historic Treatment Program: Submit 30 days before work begins.
- D. Fire-Prevention Plan: Submit 30 days before work begins.

1.08 QUALITY ASSURANCE

- A. Historic Treatment Specialist Qualifications: An experienced firm regularly engaged in historic treatments similar in nature, materials, design, and extent to the work as specified in each Section and that has completed a minimum of five recent projects with a record of successful in-service performance that demonstrates the firm's qualifications to perform this work.
 - 1. Field Supervisor Qualifications: Full-time supervisors experienced in historic treatment work similar in nature, material, design, and extent to that indicated for this Project. Supervisors shall be on site when historic treatment work begins and during its progress. Supervisors shall not be changed during Project except for causes beyond control of the specialist firm.
 - a. Construct new mockups of required work whenever a supervisor is replaced.
- B. Title X Requirement: Each firm conducting activities that disturb painted surfaces shall be a "Lead-Safe Certified Firm" according to 40 CFR 745, Subpart E, and use only workers that are trained in lead-safe work practices.
- C. Historic Treatment Program: Prepare a written plan for historic treatment for whole Project, including each phase or process and protection of surrounding materials during operations. Describe in detail the materials, methods, and equipment to be used for each phase of work. Show compliance with indicated methods and procedures specified in this and other Sections. Coordinate this whole-Project historic treatment program with specific requirements of programs required in other historic treatment Sections.
 - 1. Dust and Noise Control: Include locations of proposed temporary dust- and noise-control partitions and means of egress from occupied areas coordinated with continuing on-site operations and other known work in progress.
 - 2. Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and locations and details of temporary protective barriers.
- D. Fire-Prevention Plan: Prepare a written plan for preventing fires during the Work, including placement of fire extinguishers, fire blankets, rag buckets, and other fire-control devices during each phase or process. Coordinate plan with Owner's fire-protection equipment and requirements. Include fire-watch personnel's training, duties, and authority to enforce fire safety.
- E. Safety and Health Standard: ANSI/ASSE A10.6.

1.09 STORAGE AND HANDLING OF HISTORIC MATERIALS

- A. Salvaged Historic Materials:
 - 1. Clean loose dirt and debris from salvaged historic items unless more extensive cleaning is indicated.
 - 2. Pack or crate items after cleaning; cushion against damage during handling. Label contents of containers.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to Owner's storage area designated by Owner.
 - 5. Protect items from damage during transport and storage.
- B. Historic Materials for Reinstallation:
 - 1. Repair and clean historic items for reuse as indicated.
 - 2. Pack or crate items after cleaning and repairing; cushion against damage during handling. Label contents of containers.
 - 3. Protect items from damage during transport and storage.
 - 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment unless otherwise indicated. Provide connections, supports, and miscellaneous materials to make items functional for use indicated.

- C. Existing Historic Materials to Remain: Protect construction indicated to remain against damage and soiling from construction work. Where permitted by Architect, items may be dismantled and taken to a suitable, protected storage location during construction work and reinstalled in their original locations after historic treatment and construction work in the vicinity is complete.
- D. Historic Materials for Replication:
 - 1. Repair and clean historic items for replication as indicated.
 - 2. Provide a record of items by a method recommended by a qualified historic treatment specialist after cleaning and repairing, cushion against damage during handling. Label contents of containers.
 - 3. Protect items from damage during transport and storage.
 - 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment unless otherwise indicated. Provide connections, supports, and miscellaneous materials to make items functional for use indicated.
- E. Storage: Catalog and store historic items within a weathertight enclosure where they are protected from moisture, weather, condensation, and freezing temperatures.
 - 1. Identify each item with a nonpermanent mark to document its original location. Indicate original locations on plans, elevations, sections, or photographs by annotating the identifying marks.
 - 2. Secure stored materials to protect from theft.
 - 3. Control relative humidity so that it ~~does not exceed 85 percent. Maintain temperatures 5 deg F (3 deg C)~~ stays within 32 - 39 percent with the goal of keeping the wood water content around 7%. Maintain temperatures 5 deg F (3 deg C) or more above the dew point.
 - 4. does not exceed 85 percent. Maintain temperatures 5 deg F (3 deg C)
- F. Storage Space:
 - 1. ~~Owner will arrange for limited on-site location(s) for free storage of historic material. This storage space does not include security for stored material.~~
 - 2. Arrange for off-site locations for storage and protection of historic material that cannot be stored and protected on-site.
 - 3. Subject to requirements of the material, conditioned storage may be warranted as noted above.

1.10 FIELD CONDITIONS

- A. Size Limitations in Historic Spaces: Materials, products, and equipment used for performing the Work and for transporting debris, materials, and products shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by 12 inches (300 mm) or more.

PART 2 PRODUCTS - (NOT USED)

PART 3 EXECUTION

3.01 PROTECTION

- A. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from historic treatment procedures.
 - 1. Use only proven protection methods, appropriate to each area and surface being protected.
 - 2. Provide temporary barricades, barriers, and directional signage to exclude the public from areas where historic treatment work is being performed.
 - 3. Erect temporary barriers to form and maintain fire-egress routes.
 - 4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during historic treatment work.
 - 5. Contain dust and debris generated by historic treatment work and prevent it from reaching the public or adjacent surfaces.
 - 6. Provide shoring, bracing, and supports as necessary. Do not overload structural elements.
 - 7. Protect floors and other surfaces along hauling routes from damage, wear, and staining.

8. Provide supplemental sound-control treatment to isolate removal and dismantling work from other areas of the building.
- B. Temporary Protection of Historic Materials:
 1. Protect existing historic materials with temporary protections and construction. Do not remove existing materials unless otherwise indicated.
 2. Do not attach temporary protection to historic surfaces except as indicated as part of the historic treatment program and approved by Architect.
- C. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
- D. Utility and Communications Services:
 1. Notify Owner, Architect, authorities having jurisdiction, and entities owning or controlling wires, conduits, pipes, and other services affected by historic treatment work before commencing operations.
 2. Disconnect and cap pipes and services as required by authorities having jurisdiction, as required for historic treatment work.
 3. Maintain existing services unless otherwise indicated; keep in service and protect against damage during operations. Provide temporary services during interruptions to existing utilities.
- E. Existing Drains: Prior to the start of work in an area, test drainage system to ensure that it is functioning properly. Notify Architect immediately of inadequate drainage or blockage. Do not begin work in an area until the drainage system is functioning properly.
 1. Prevent solids such as stone or mortar residue or other debris from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from historic treatment work.
 2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.
- F. Existing Roofing: Prior to the start of work in an area, install roofing protection.

3.02 PROTECTION FROM FIRE

- A. Follow fire-prevention plan and the following:
 1. Comply with NFPA 241 requirements unless otherwise indicated. Perform duties titled "Owner's Responsibility for Fire Protection."
 2. Remove and keep area free of combustibles, including rubbish, paper, waste, and chemicals, unless necessary for the immediate work.
 - a. If combustible material cannot be removed, provide fire blankets to cover such materials.
 3. Prohibit smoking by all persons within Project work and staging areas.
- B. Heat-Generating Equipment and Combustible Materials: Comply with the following procedures while performing work with heat-generating equipment or combustible materials, including welding, torch-cutting, soldering, brazing, removing paint with heat, or other operations where open flames or implements using high heat or combustible solvents and chemicals are anticipated:
 1. Obtain Owner's approval for operations involving use of open-flame or welding or other high-heat equipment. Notify Owner at least 72 hours before each occurrence, indicating location of such work.
 2. As far as practicable, restrict heat-generating equipment to shop areas or outside the building.
 3. Do not perform work with heat-generating equipment in or near rooms or in areas where flammable liquids or explosive vapors are present or thought to be present. Use a combustible gas indicator test to ensure that area is safe.
 4. Use fireproof baffles to prevent flames, sparks, hot gases, or other high-temperature material from reaching surrounding combustible material.

5. Prevent the spread of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, roofs, and other openings.
 6. Fire Watch: Before working with heat-generating equipment or combustible materials, station personnel to serve as a fire watch at each location where such work is performed. Fire-watch personnel shall have the authority to enforce fire safety. Station fire watch according to NFPA 51B, NFPA 241, and as follows:
 - a. Train each fire watch in proper operation of fire-control equipment and alarms.
 - b. Prohibit fire-watch personnel from other work that would distract from fire-watch duties.
 - c. Cease work with heat-generating equipment whenever fire-watch personnel are not present.
 - d. Have fire-watch personnel perform final fire-safety inspection each day beginning no sooner than 30 minutes after conclusion of work in each area to detect hidden or smoldering fires and to ensure that proper fire prevention is maintained.
 - e. Maintain fire-watch personnel at each area of Project site until 60 minutes after conclusion of daily work.
- C. Fire-Control Devices: Provide and maintain fire extinguishers, fire blankets, and rag buckets for disposal of rags with combustible liquids. Maintain each as suitable for type of fire risk in each work area. Ensure that nearby personnel and fire-watch personnel are trained in fire-extinguisher and blanket use.
- D. Sprinklers: Where sprinkler protection exists and is functional, maintain it without interruption while operations are being performed. If operations are performed close to sprinklers, shield them temporarily with guards.
1. Remove temporary guards at the end of work shifts, whenever operations are paused, and when nearby work is complete.

3.03 PROTECTION DURING APPLICATION OF CHEMICALS

- A. Protect motor vehicles, surrounding surfaces of building being restored, building site, plants, and surrounding buildings from harm or spillage resulting from applications of chemicals and adhesives.
- B. Cover adjacent surfaces with protective materials that are proven to resist chemicals selected for Project unless chemicals being used will not damage adjacent surfaces as indicated in historic treatment program. Use covering materials and masking agents that are waterproof and UV resistant and that will not stain or leave residue on surfaces to which they are applied. Apply protective materials according to manufacturer's written instructions. Do not apply liquid masking agents or adhesives to painted or porous surfaces. When no longer needed, promptly remove protective materials.
- C. Do not apply chemicals during winds of sufficient force to spread them to unprotected surfaces.
- D. Neutralize alkaline and acid wastes and legally dispose of off Owner's property.
- E. Collect and dispose of runoff from chemical operations by legal means and in a manner that prevents soil contamination, soil erosion, undermining of paving and foundations, damage to landscaping, or water penetration into building interior.

3.04 GENERAL HISTORIC TREATMENT

- A. Have historic treatment work performed only by qualified historic treatment specialists.
- B. Ensure that supervisory personnel are present when historic treatment work begins and during its progress.
- C. Record existing work before each procedure (preconstruction), and record progress during the work. Use digital preconstruction documentation photographs or video recordings. Comply with requirements in Section 013233 "Photographic Documentation."
- D. Perform regular inspections of Project site as the Work progresses to detect hazards resulting from historic treatment procedures.
- E. Follow the procedures in subparagraphs below and procedures approved in historic treatment program unless otherwise indicated:

1. Retain as much existing material as possible; repair and consolidate rather than replace.
 2. Use additional material or structure to reinforce, strengthen, prop, tie, and support existing material or structure.
 3. Use reversible processes wherever possible.
 4. Use historically accurate repair and replacement materials and techniques unless otherwise indicated.
 5. Record existing work before each procedure (preconstruction) and progress during the work with digital preconstruction documentation photographs or video recordings. Comply with requirements in Section 013233 "Photographic Documentation."
- F. Notify Architect of visible changes in the integrity of material or components whether from environmental causes including biological attack, UV degradation, freezing, or thawing or from structural defects including cracks, movement, or distortion.
1. Do not proceed with the work in question until directed by Architect.
- G. Where missing features are indicated to be repaired or replaced, provide work with appearance based on accurate duplications rather than on conjecture, subject to approval of Architect.
- H. Where work requires existing features to be removed or dismantled and reinstalled, perform these operations without damage to the material itself, to adjacent materials, or to the substrate.
- I. Identify new and replacement materials and features with permanent marks hidden in the completed Work to distinguish them from original materials. Record a legend of identification marks and the locations of the items on record Drawings.

3.05 HISTORIC TREATMENT SCHEDULE

- A. Spaces, areas, rooms, and surfaces requiring special care and treatment to ensure successful preservation, rehabilitation and restoration are indicated on Drawings.

END OF SECTION 013591

**SECTION 014000
QUALITY REQUIREMENTS**

ADDENDUM #01 OCT 19, 2022

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Quality assurance.
- B. Testing and inspection agencies and services.
- C. Control of installation.
- D. Mock-ups.
- E. Defect Assessment.

1.02 REFERENCE STANDARDS

- A. ASTM C1021 - Standard Practice for Laboratories Engaged in Testing of Building Sealants 2008 (Reapproved 2023).
- B. ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation 2017.
- C. ASTM C1093 - Standard Practice for Accreditation of Testing Agencies for Masonry 2023.
- D. 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 2019.
- E. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection 2021.
- F. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing 2021.
- G. ASTM E699 - Standard Specification for Agencies Involved in Testing, Quality Assurance, and Evaluating of Manufactured Building Components 2016.
- H. IAS AC89 - Accreditation Criteria for Testing Laboratories 2021.

1.03 DEFINITIONS

- A. Contractor's Quality Control Plan: Contractor's management plan for executing the Contract for Construction.
- B. Contractor's Professional Design Services: Design of some aspect or portion of the project by party other than the design professional of record. Provide these services as part of the Contract for Construction.
 - 1. Design Services Types Required:
 - a. Construction-Related: Services Contractor needs to provide in order to carry out the Contractor's sole responsibilities for construction means, methods, techniques, sequences, and procedures.
- C. Design Data: Design-related, signed and sealed drawings, calculations, specifications, certifications, shop drawings and other submittals provided by Contractor, and prepared directly by, or under direct supervision of, appropriately licensed design professional.

1.04 TESTING AND INSPECTION AGENCIES AND SERVICES

- A. Owner will employ and pay for services of an independent testing agency to perform other specified testing.
- B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.
- D. Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Have work performed by persons qualified to produce required and specified quality.
- F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.02 MOCK-UPS

- A. Before installing portions of the Work where mock-ups are required, construct mock-ups in location and size indicated for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work. The purpose of mock-up is to demonstrate the proposed range of aesthetic effects and workmanship.
- B. Accepted mock-ups establish the standard of quality the Architect will use to judge the Work.
- C. Tests shall be performed under provisions identified in this section and identified in the respective product specification sections.
- D. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- E. Architect will use accepted mock-ups as a comparison standard for the remaining Work.
- F. Where mock-up has been accepted by Architect and is specified in product specification sections to be removed, protect mock-up throughout construction, remove mock-up and clear area when directed to do so by Architect.

3.03 TESTING AND INSPECTION

- A. Testing Agency Duties:
 - 1. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
 - 2. Perform specified sampling and testing of products in accordance with specified standards.
 - 3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 - 4. Promptly notify Architect and Contractor of observed irregularities or non-compliance of Work or products.
 - 5. Perform additional tests and inspections required by Architect.
 - 6. Submit reports of all tests/inspections specified.
- B. Limits on Testing/Inspection Agency Authority:
 - 1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Agency may not approve or accept any portion of the Work.
 - 3. Agency may not assume any duties of Contractor.
 - 4. Agency has no authority to stop the Work.
- C. Contractor Responsibilities:

1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
 2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
 3. Provide incidental labor and facilities:
 - a. To provide access to Work to be tested/inspected.
 - b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
 - c. To facilitate tests/inspections.
 - d. To provide storage and curing of test samples.
 4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
 5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
 6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
- D. Re-testing required because of non-compliance with specified requirements shall be performed by the same agency on instructions by Architect.
- E. Re-testing required because of non-compliance with specified requirements shall be paid for by Contractor.

3.04 DEFECT ASSESSMENT

- A. Replace Work or portions of the Work not complying with specified requirements.

END OF SECTION 014000

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**SECTION 015000
TEMPORARY FACILITIES AND CONTROLS**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

1.03 USE CHARGES

- A. Installation, removal, and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, testing agencies, and authorities having jurisdiction.
- B. Sewer Service: Pay sewer-service use charges for sewer usage by all entities for construction operations.
- C. Water Service: Pay water-service use charges for water used by all entities for construction operations.
- D. Electric Power Service: Pay electric-power-service use charges for electricity used by all entities for construction operations.
- E. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use with metering. Provide connections and extensions of services and metering as required for construction operations.
- F. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use with metering. Provide connections and extensions of services and metering as required for construction operations.

1.04 INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
- B. Implementation and Termination Schedule: Within 15 days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.
- C. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.
- D. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- E. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold. Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
 - 1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and requirements for replacing water-damaged Work.
 - 2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.

3. Indicate methods to be used to avoid trapping water in finished work.
- F. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:
 1. Locations of dust-control partitions at each phase of work.
 2. HVAC system isolation schematic drawing.
 3. Location of proposed air-filtration system discharge.
 4. Waste-handling procedures.
 5. Other dust-control measures.
- G. Noise and Vibration Control Plan: Identify construction activities that may impact the occupancy and use of existing spaces within the building or adjacent existing buildings, whether occupied by others, or occupied by the Owner. Include the following:
 1. Methods used to meet the goals and requirements of the Owner.
 2. Concrete cutting method(s) to be used.
 3. Location of construction devices on the site.
 4. Show compliance with the use and maintenance of quieted construction devices for the duration of the Project.
 5. Indicate activities that may disturb building occupants and that are planned to be performed during non-standard working hours as coordinated with the Owner.
 6. Indicate locations of sensitive areas or other areas requiring special attention as identified by Owner. Indicate means for complying with Owner's requirements.

1.05 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.06 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Portable Chain-Link Fencing: Minimum 2-inch (50-mm), 0.148-inch- (3.8-mm-) thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized-steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top and bottom rails. Provide galvanized-steel bases for supporting posts.
- B. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain-link fence, sized to height of fence, in color selected by Architect from manufacturer's standard colors.
- C. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil (0.25-mm) minimum thickness, with flame-spread rating of 15 or less in accordance with ASTM E84 and passing NFPA 701 Test Method 2.

2.02 TEMPORARY FACILITIES

- A. Field Offices: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, and construction personnel office activities and to accommodate Project meetings specified in other

Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:

1. Furniture required for Project-site documents, including file cabinets, plan tables, plan racks, and bookcases.
 2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- (1.2-m-) square tack and marker boards.
 3. Drinking water and private toilet.
 4. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).
 5. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.
- C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
1. Store combustible materials apart from building.

2.03 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 2. Heating, Cooling, and Dehumidifying Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
 3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction.
- C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 EXECUTION

3.01 TEMPORARY FACILITIES, GENERAL

- A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

3.02 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.
- C. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
1. Prior to commencing work, isolate the HVAC system in area where work is to be performed according to coordination drawings.
 - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.

- b. Maintain negative air pressure within work area, using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.

3.03 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- D. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- E. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 1. Use of Permanent Toilets: Use of Owner's existing or new toilet facilities is not permitted.
- F. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
 1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.
- G. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
 1. Install electric power service overhead unless otherwise indicated.
 2. Connect temporary service to Owner's existing power source, as directed by Owner.
- H. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- I. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install WiFi cell phone access equipment and one land-based telephone line(s) for each field office.
 1. At each telephone, post a list of important telephone numbers.
 - a. Police and fire departments.
 - b. Ambulance service.
 - c. Contractor's home office.
 - d. Contractor's emergency after-hours telephone number.
 - e. Architect's office.
 - f. Engineers' offices.
 - g. Owner's office.
 - h. Principal subcontractors' field and home offices.

- J. Electronic Communication Service: Provide secure WiFi wireless connection to internet with provisions for access by Architect and Owner.
- K. Project Computer: Provide a desktop computer in the primary field office adequate for use by Architect and Owner to access Project electronic documents and maintain electronic communications. Equip computer with not less than the following:
 - 1. Processor: Intel Core i5 or i7.
 - 2. Memory: 16 gigabyte.
 - 3. Disk Storage: 1 -terabyte hard-disk drive and combination DVD-RW/CD-RW drive.
 - 4. Display: 24-inch (610-mm) LCD monitor with 256-Mb dedicated video RAM.
 - 5. Full-size keyboard and mouse.
 - 6. Network Connectivity: 10/100BaseT Ethernet.
 - 7. Operating System: Microsoft Windows 10 Professional.
 - 8. Productivity Software:
 - a. Microsoft Office Professional, 2013 or higher, including Word, Excel, and Outlook.
 - b. Adobe Reader DC.
 - c. WinZip 10.0 or higher.
 - 9. Printer: "All-in-one" unit equipped with printer server, combining color printing, photocopying, scanning, and faxing, or separate units for each of these three functions.
 - 10. Internet Service: Broadband modem, router, and ISP, equipped with hardware firewall, providing minimum 10.0 -Mbps upload and 15 -Mbps download speeds at each computer.
 - 11. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.
 - 12. Backup: External hard drive, minimum 2 terrabytes, with automated backup software providing daily backups.

3.04 SUPPORT FACILITIES INSTALLATION

- A. Comply with the following:
 - 1. Provide construction for temporary field offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines that is noncombustible in accordance with ASTM E136. Comply with NFPA 241.
 - 2. Utilize designated area within existing building for temporary field offices.
 - 3. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Traffic Controls: Comply with requirements of authorities having jurisdiction.
 - 1. Protect existing site improvements to remain, including curbs, pavement, and utilities.
 - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- C. Parking: Provide temporary offsite parking areas for construction personnel.
- D. Storage and Staging: Use designated areas of Project site for storage and staging needs.
- E. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
 - 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 - 2. Remove snow and ice as required to minimize accumulations.
- F. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
 - 1. Identification Signs: Provide Project identification signs as indicated on Drawings.
 - 2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
 - a. Provide temporary, directional signs for construction personnel and visitors.
 - 3. Maintain and touch up signs, so they are legible at all times.
- G. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- H. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- I. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.
 1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas, so no evidence remains of correction work.

3.05 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
 1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
 1. Comply with work restrictions specified in Section 011000 "Summary."
- C. Temporary Erosion and Sedimentation Control: Comply with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Section 311000 "Site Clearing."
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion as specified in Section 015639 "Temporary Tree Protection".
- F. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals, so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.
- G. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.
 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner.
- H. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.
- I. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- J. Temporary Egress: Provide temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.
- K. Covered Walkway: Erect protective, covered walkway for passage of individuals through or adjacent to Project site. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction.

1. Provide overhead decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
 2. Paint and maintain appearance of walkway for duration of the Work.
- L. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- M. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition in accordance with requirements of authorities having jurisdiction.
 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign, stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.06 MOISTURE AND MOLD CONTROL

- A. Moisture and Mold Protection: Protect stored materials and installed Work in accordance with Moisture and Mold Protection Plan.
- B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
1. Protect porous materials from water damage.
 2. Protect stored and installed material from flowing or standing water.
 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 4. Remove standing water from decks.
 5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 2. Keep interior spaces reasonably clean and protected from water damage.
 3. Periodically collect and remove waste containing cellulose or other organic matter.
 4. Discard or replace water-damaged material.
 5. Do not install material that is wet.
 6. Discard and replace stored or installed material that begins to grow mold.
 7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.
- D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
 - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet

- for 48 hours are considered defective and require replacing.
- b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
 - c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.07 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period.

END OF SECTION 015000

**SECTION 017419
CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL**

ADDENDUM #01 OCT 19, 2022

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous demolition and construction waste.
 - 2. Disposing of nonhazardous demolition and construction waste.
- B. Related Requirements:
 - 1. Section 024296 "Historic Removal and Dismantling" for handling requirements for historic material.

1.03 DEFINITIONS

- A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.
- C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner's property.
- D. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- E. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.04 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.05 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 7 days of date established for commencement of the Work.

1.06 INFORMATIONAL SUBMITTALS

- A. ~~Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.~~
- B. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- C. Qualification Data: For waste management coordinator and refrigerant recovery technician.
- D. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

- E. Refrigerant Recovery: Comply with requirements in Section 024116 "Structure Demolition" Section 024119 "Selective Demolition" for refrigerant recovery submittals.

1.07 QUALITY ASSURANCE

- A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by General Contractor, with a record of successful waste management coordination of projects with similar requirements. Superintendent may serve as Waste Management Coordinator.
- B. Refrigerant Recovery Technician Qualifications: Universal certified by EPA-approved certification program.
- C. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.
- D. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:
 - 1. Review and discuss waste management plan including responsibilities of each contractor and waste management coordinator.
 - 2. Review requirements for documenting quantities of each type of waste and its disposition.
 - 3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
 - 4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
 - 5. Review waste management requirements for each trade.

1.08 WASTE MANAGEMENT PLAN

- A. Waste Identification: Indicate anticipated types and quantities of demolition and construction waste generated by the Work. Use a form suitable to the owner. Include estimated quantities and assumptions for estimates.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 - 1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."
- B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
 - 1. Distribute waste management plan to everyone concerned within three days of submittal return.
 - 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- C. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged.
 - 2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.
- D. Waste Management in Historic Zones or Areas: Transportation equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, by 12 inches (300 mm) or more.

3.02 SALVAGING DEMOLITION WASTE

- A. Comply with requirements in Section 024296 "Historic Removal and Dismantling " for salvaging demolition waste.
- B. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 - 3. Store items in a secure area until installation.
 - 4. Protect items from damage during transport and storage.
 - 5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- C. Salvaged Items for Sale and Donation: Not permitted on Project site.
- D. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to Owner's storage area on-site.
 - 5. Protect items from damage during transport and storage.
- E. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.
- F. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
- G. Plumbing Fixtures: Separate by type and size.
- H. Lighting Fixtures: Separate lamps by type and protect from breakage.
- I. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.03 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 - 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. General: Except for items or materials to be salvaged or recycled, remove waste materials and legally dispose of at designated spoil areas on Owner's property.
- C. Burning: Do not burn waste materials.
- D. Burning: Burning of waste materials is permitted only at designated areas on Owner's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.

END OF SECTION 017419

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**SECTION 020342
REMOVAL AND SALVAGE OF PERIOD CONSTRUCTION MATERIALS**

EXECUTED AS PART OF BID PACKAGE 01

PART 1 GENERAL

2.01 SECTION INCLUDES

- A. Work includes deconstruction and salvage of identified historic items and materials and removal of rubbish and debris.
- B. Specified procedures required for preservation, rehabilitation, restoration, and reconstruction treatment areas.
- C. Historic items and materials are indicated on drawings.

2.02 RELATED REQUIREMENTS

- A. Section 013591 - Period Treatment Procedures for general historic preservation project requirements.
- B. Section 024100 - Demolition: Selective demolition of nonhistoric building elements for alteration purposes.

2.03 DEFINITIONS

- A. Debris: Nonhistoric building materials and contents destroyed during demolition.
- B. Deconstruction: Systematic dismantling and removal of a structure or its parts and salvage of elements and components for reuse, recycling, and retaining maximum value.

2.04 REFERENCE STANDARDS

- A. 29 CFR 1926 - Safety and Health Regulations for Construction Current Edition.
- B. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations 2022.

2.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Deconstruction Crew's Qualification Statement: Documentation of three consecutive years of work of this type, including similar projects identifying when, where, and for whom the work was performed.
 - 1. Include current point-of-contact information for references.
- C. Work Plan: Detailed, proposed instructions for each type of operation of procedures for accomplishment of deconstruction work, including detailed description of the methods and equipment to be used and sequence of operations. Include the following:
 - 1. Extent of deconstruction, removal sequences, temporary and permanent bracing and shoring, and location and construction of barricades and fences.
 - 2. Instructions for removal and disposition of period materials specified to be salvaged or recycled.
 - 3. Dust control measures.
 - 4. Protection of property to remain undisturbed.
 - 5. Ensure coordination with other work.
 - 6. Plan for sequencing and timely disconnection and reconnection of utility services.
 - 7. Safe conduct of the work. Submit for information only.

2.06 QUALITY ASSURANCE

- A. Deconstruction Crew Qualifications: Workers trained and experienced in removal and salvage of historic materials.

2.07 FIELD CONDITIONS

- A. Comply with applicable requirements of NFPA 241.

- B. Dust Control: Control dust resulting from removal, salvage, and demolition operations from spreading to occupied portions of the project and creating a nuisance in surrounding area. Use of water to control dust is not permitted when it will result in or create:
 - 1. Damage to existing building materials.
 - 2. Hazardous or objectionable conditions such as ice, flooding, or pollution.
- C. Protection of Existing Historic Property: Before beginning removal, salvage, or demolition work, survey the site and examine the drawings and specifications to determine the extent of the work. Take necessary precautions to avoid damage to existing items to remain in place, be reused, or remain Owner's property. Repair or restore to original condition items damaged by Contractor, using approved means, methods, and techniques. Replace items that cannot be successfully repaired or restored to original condition.
- D. Store materials to be salvaged or recycled daily, out of contact with the ground, under weathertight covering, in areas designated by Owner, and in the manner direct by Owner.
- E. Hazardous Materials: Comply with 29 CFR 1926 and state and local regulations.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

4.01 PERIOD TREATMENT, GENERAL

- A. See Section 013591 for special procedure requirements related to elements and features of historical significance and value.

4.02 GENERAL PROCEDURES

- A. Drawings indicating existing construction, building services, and site utilities are based on casual field observation and existing record documents only.
 - 1. Report discrepancies to Architect before disturbing existing historic elements.
 - 2. Beginning of work constitutes acceptance of existing conditions that are apparent upon examination at that time.
- B. Separate spaces in which removals and salvage operations are conducted from occupied spaces.
 - 1. Provide, erect, and maintain temporary dustproof partitions; see Section 015000.

4.03 ENVIRONMENTAL CONTROLS

- A. Comply with federal, state, and local regulations pertaining to water, air, solid waste, recycling, chemical waste, sanitary waste, sediment, and noise pollution.
- B. Protection of Natural Resources: Preserve the natural resources within the project boundaries or restore to an equivalent condition.
 - 1. Confine removal activities to areas defined by public roads, easements, and work area limits indicated on drawings.
 - a. Temporary Construction: At the conclusion of the project, remove indications of temporary construction facilities, such as haul roads, work areas, structures, stockpiles, or waste areas.
 - 2. Water Resources: Comply with applicable regulations concerning direct or indirect discharge of pollutants to underground and natural surface waters.
 - a. Oily Substances: Prevent oily or other hazardous substances from entering the ground, drainage areas, or local bodies of water in such quantities as to affect normal use, aesthetics, or produce a measurable ecological impact on the area.
 - 1) Store and service construction equipment at areas designated for collection of oil wastes.
 - 3. Dust Control, Air Pollution, and Odor Control: Prevent creation of dust, air pollution, and odors.
 - a. Use temporary enclosures and other appropriate methods to limit dust and dirt rising and scattering in air to lowest practical level.
 - b. Store volatile liquids, including fuels and solvents, in closed containers.
 - c. Properly maintain equipment to reduce gaseous pollutant emissions.

4. Noise Control: Perform removal operations to minimize noise.

4.04 ITEMS TO BE SALVAGED

- A. General: Salvage elements and components to the maximum extent possible. Maintain a chain of custody of salvaged materials, including the condition of such materials before and after salvage operations.
 1. Remove historic items to be salvaged from the structure prior to deconstruction work.
 2. Accomplish removal of salvageable items by hand labor to the maximum extent possible.
 3. Take care not to damage historic portions of the structure scheduled to remain or items identified for salvage.
 4. Obtain hot work permits for removal of elements requiring use of fire- or spark-producing tools or activities that produce sources of ignition.
- B. Metal Elements: Remove intact and salvage metal elements indicated on drawings.
- C. Wood Elements: Remove intact and salvage wood elements indicated on drawings.
- D. Doors and Windows: Remove intact and salvage doors and windows indicated on drawings.
- E. Finishes: Protect special or historic finishes and finish elements indicated on drawings.
- F. Equipment and Specialty Elements: Remove intact and salvage specialty elements indicated on drawings.
- G. Mechanical Equipment: Remove intact and salvage equipment and fixtures indicated on drawings.
- H. Electrical Equipment: Remove intact and salvage equipment and fixtures indicated on drawings.

4.05 MATERIALS TO BE REMOVED

- A. Remove existing nonhistoric elements as indicated and as required to allow direct access to period construction elements indicated to be restored or salvaged for reuse.
 1. Remove items indicated on drawings.
- B. Services: Remove existing systems and equipment to extent indicated, including but not limited to Fire Protection, Plumbing, HVAC, Electrical, and Telecommunications elements:
 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and other operational components.
 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service switchover.
 3. Verify that abandoned services serve only abandoned facilities prior to commencing removals.
 4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stubs and tag with identification.
- C. Protect existing historic elements.
 1. Prevent movement of structure; provide temporary, removable shoring and bracing if necessary.
 2. Perform cutting to accomplish removals neatly, minimizing overcutting.

4.06 CLEANING

- A. Upon completion of work, clean dust, dirt, and debris caused by salvage and demolition operations from portions of existing structure to remain and adjacent areas. Remove and transport debris and rubbish in a manner that prevents spillage on streets or adjacent areas. Obey local regulations regarding hauling and disposal.

END OF SECTION 020342

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**SECTION 024119
SELECTIVE DEMOLITION**

EXECUTED AS PART OF BID PACKAGE 01

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Demolition and removal of selected portions of building or structure.
 - 2. Demolition and removal of selected site elements.
 - 3. Salvage of existing items to be reused or recycled.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
 - 2. Section 013591 "Historic Treatment Procedures" for general protection and work procedures for alteration projects.
 - 3. Section 017300 "Execution" for cutting and patching procedures
 - 4. Section 024296 "Historic Removal and Dismantling" for historic features to be documented for re-use.

1.03 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.04 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.05 PREINSTALLATION MEETINGS

- A. Pre-demolition Conference: Conduct conference at Project site.
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 - 5. Review areas where existing construction is to remain and requires protection.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Engineering Survey: Submit engineering survey of condition of building.
- C. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.
- D. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- E. Pre-demolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before Work begins.
- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- G. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.07 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

1.08 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.09 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
 - 1. Before selective demolition, Owner will remove the following items:
 - a. Stored Items residing within the building.
 - b. Furniture, Fixtures, and Equipment (FF&E).
 - c. State History collections in basement.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. Hazardous materials will be removed by Owner before start of the Work.
 - 2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Hazardous Materials: Present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
 - 1. Hazardous material remediation is specified elsewhere in the Contract Documents.

2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
 3. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.
- F. Historic Areas: Demolition and hauling equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by 12 inches or more.
- G. Storage or sale of removed items or materials on-site is not permitted.
- H. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
1. Maintain fire-protection facilities in service during selective demolition operations.

1.10 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors who specialize in clay tile work, so as to not compromise the integrity of the existing roofing system. ~~void existing warranties. Notify warrantor before proceeding. Existing warranties include the following:~~
1. ~~Roof.~~
- B. ~~Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.~~
- C. Notify Owner for inspection and verification by qualified roofing inspector selected and by the Owner.

1.11 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
- D. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
- E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

- F. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs or video.
 - 1. Comply with requirements specified in Section 013233 "Photographic Documentation."
 - 2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
 - 3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.02 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.03 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 - 2. Arrange to shut off utilities with utility companies.
 - 3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.04 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
 - 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
 - 1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

3.05 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 - 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 - 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 - 5. Maintain fire watch during and for at least 2 hours after flame-cutting operations.
 - 6. Maintain adequate ventilation when using cutting torches.
 - 7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 - 8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 - 9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 - 10. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Work in Historic Areas: Selective demolition may be performed only in areas of Project that are not designated as historic. In historic spaces, areas, and rooms, or on historic surfaces, the terms "demolish" or "remove" shall mean historic "removal" or "dismantling" as specified in Section 013591 Historic Treatment Procedures."
- D. Removed and Salvaged Items:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to Owner's storage area on-site or designated by Owner.
 - 5. Protect items from damage during transport and storage.
- E. Removed and Reinstalled Items:
 - 1. Clean and repair items to functional condition adequate for intended reuse.
 - 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 - 3. Protect items from damage during transport and storage.
 - 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

- F. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.06 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
- B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.
- C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.
- E. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.
- F. Roofing: Remove no more existing roofing than what is required for new venting and exhaust than can be covered in one day by new roofing and so that building interior remains watertight and weathertight.

3.07 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction. and recycle or dispose of them according to Section 017419 "Construction Waste Management and Disposal."
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- B. Burning: Do not burn demolished materials.

3.08 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.09 SELECTIVE DEMOLITION SCHEDULE

- A. Remove: Concrete floor, temporary opening coverings, shelving and overhead sectional door as designated on the drawings.
- B. Remove and Salvage: Loose historic items.
- C. Remove and Reinstall: Windows, doors, trim as designated on the drawings.
- D. Existing to Remain: Trim, masonry, historic grain mechanisms, roofing as designated on the drawings.
- E. Dismantle: N/A.

END OF SECTION 024119

END OF SECTION 024119

**SECTION 024296
HISTORIC REMOVAL AND DISMANTLING**

ADDENDUM #01 OCT 19, 2022

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes historic treatment procedures in the form of special types of selective demolition work for designated historic spaces, areas, rooms, and surfaces and the following specific work:
 - 1. Removal and dismantling of indicated portions of building or structure and debris hauling.
 - 2. Salvage of existing items to be reused or recycled.
- B. Related Requirements:
 - 1. Section 013591 "Historic Treatment Procedures" for general historic treatment requirements.

1.03 DEFINITIONS

- A. Dismantle: To disassemble or detach a historic item from a surface, or a non-historic item from a historic surface, using gentle methods and equipment to prevent damage to historic items and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- B. Existing to Remain: Existing items that are not to be removed or dismantled, except to the degree indicated for performing required Work.
- C. Remove: To take down or detach a non-historic item located within a historic space, area, or room, using methods and equipment to prevent damage to historic items and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- D. Retain: To keep existing items that are not to be removed or dismantled.
- E. Salvage: To protect removed or dismantled items and deliver them to Owner.

1.04 PRECONSTRUCTION MEETINGS

- A. Preconstruction Conference(s): Conduct conference(s) at Project site.
 - 1. Review minutes of Preliminary Historic Treatment Conference that pertain to removal and dismantling procedures and protection of historic areas and surfaces.
 - 2. Review list of items indicated to be salvaged.
 - 3. Verify qualifications of personnel assigned to perform removal and dismantling.
 - 4. Inspect and discuss condition of each construction type to be removed or dismantled.
 - 5. Review requirements of other work that depends on condition of substrates exposed by removal and dismantling work.
 - 6. Review methods and procedures related to removal and dismantling work, including, but not limited to, the following:
 - a. Historic removal and dismantling specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.
 - c. Fire prevention.
 - d. Coordination with building occupants.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For historic removal and dismantling specialist.
- B. Preconstruction Documentation: Show preexisting conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by Contractor's removal and dismantling operations.
- C. Removal and Dismantling Historic Treatment Program: Submit 30 days before work begins.

- D. List of Items Indicated to Be Salvaged: Prepare a list of items indicated on Drawings to be salvaged for Owner's use or for reinstallation. Submit 15 days before preconstruction conference.
- E. Inventory of Salvaged Items: After removal or dismantling work is complete, submit a list of items that have been salvaged.
 - 1. Include item description, item condition, number of items if more than one of a type, and tag number.
 - 2. As work proceeds, include on the inventory items that were indicated to be salvaged and items of historic importance discovered during the work. Document reasons, if any, why an item indicated to be salvaged was not salvaged.

1.06 QUALITY ASSURANCE

- A. Historic Removal and Dismantling Specialist Qualifications: A qualified historic treatment specialist. General selective demolition experience is insufficient experience for historic removal and dismantling work.
 - 1. In lieu of a specialist, other experienced personnel will be considered upon demonstration of skill level by removing the following items from area(s) to be discarded and not reinstalled. This work to be completed and approved before mockups listed below in paragraph 1.06.C.:
 - a. Door and Frame
 - b. Door casing and trim
 - c. Wall base, Approximately 30 lineal feet of base, including inside and outside corners.
- B. Removal and Dismantling Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for each phase of removal and dismantling work, including protection of surrounding and substrate materials and Project site.
 - 1. Dust and Noise Control: Include locations of proposed temporary dust- and noise-control partitions and means of egress from occupied areas coordinated with continuing on-site operations and other known work in progress.
 - 2. Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and locations and details of temporary protective barriers.
- C. Mockups: Prepare mockups of specific historic removal and dismantling procedures specified in this Section to demonstrate aesthetic effects and to set quality standards for materials and execution.
 - 1. Typical Dismantling Work:
 - a. Dismantle typical North Wing first floor window trim as shown on Drawings, one (1) location.
 - b. Dismantle typical second floor window trim as shown on Drawings, one (1) location.
 - c. Dismantle one (1) section of marble base as shown on Drawings.
 - d. Dismantle one (1) panel of marble wainscot from Northwest Vestibule, as shown on Drawings.
 - e. Dismantle one (1) panel of wood wainscot from Lecture Room, as shown on Drawings.
 - f. Dismantle one (1) panel of wood wainscot from Café, 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.
- D. Regulatory Requirements: Comply with notification regulations of authorities having jurisdiction before beginning removal and dismantling work. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.07 FIELD CONDITIONS

- A. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

1. Before removal and dismantling, Owner will remove the following items:
 - a. Furniture, Fixtures, and Equipment (FF&E).
 - b. State History Collections (this work is ongoing and scheduled to be complete by mid-July).
- B. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with removal and dismantling work.
- C. Hazardous Materials: Hazardous materials are present in construction affected by removal and dismantling work. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
 1. Hazardous material remediation is specified elsewhere in the Contract Documents.
 2. Do not disturb hazardous materials or items suspected of containing hazardous materials, except under procedures specified elsewhere in the Contract Documents.
 3. If unanticipated asbestos is suspected, stop work in the area of potential hazard, shut off fans and other air handlers ventilating the area, and rope off area until the questionable material is identified. Reassign workers to continue work in unaffected areas. Resume work in the area of concern after safe working conditions are verified.
- D. Storage or sale of removed or dismantled items on-site is not permitted unless otherwise indicated.

PART 2 PRODUCTS - (NOT USED)

PART 3 EXECUTION

3.01 HISTORIC TREATMENT SPECIALISTS

- A. Historic Removal and Dismantling Specialist Firms: Subject to compliance with requirements, firms that may perform historic removal and dismantling include, but are not limited to, the following:
 1. Architectural Metal Restoration.
 2. Carver Sheet Metal Works, Inc.
 3. Historical Arts and Casting.
 4. Hydro-Tech Inc.
 5. Abstract Masonry Restoration, Inc.
 6. Childs Enterprises Masonry.
 7. Commercial Restoration Services.
 8. IMS Masonry.
 9. RJ Masonry
 10. American Heritage Window Rebuilders.
 11. Classic Furniture Services.
 12. Historic Woods by Lunar Canyon.
 13. ReView Window Restoration.
 14. R Phillips Plastering.
 15. Evergreene Architectural Arts.

3.02 HISTORIC REMOVAL AND DISMANTLING EQUIPMENT

- A. Removal Equipment: Use only hand-held tools, except as follows or unless otherwise approved by Architect on a case-by-case basis:
 1. Light jackhammers are allowed subject to Architect's approval.
 2. Large air hammers are not permitted.
- B. Dismantling Equipment: Use manual, hand-held tools, except as follows or otherwise approved by Architect on a case-by-case basis:
 1. Hand-held power tools and cutting torches are permitted only as submitted in the historic treatment program. They must be adjustable so as to penetrate or cut only the thickness of material being removed.
 2. Pry bars more than 18 inches long and hammers weighing more than 2 lb are not permitted for dismantling work.

3.03 EXAMINATION

- A. Preparation for Removal and Dismantling: Examine construction to be removed or dismantled to determine best methods to safely and effectively perform removal and dismantling work. Examine adjacent work to determine what protective measures are necessary. Make explorations, probes, and inquiries as necessary to determine condition of construction to be removed or dismantled and location of utilities and services to remain that may be hidden by construction that is to be removed or dismantled.
 - 1. Verify that affected utilities are disconnected and capped.
 - 2. Inventory and record the condition of items to be removed and dismantled for reinstallation or salvage. Enter this information on the submittal of inventory of salvaged items.
 - 3. Before removal or dismantling of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.
 - 4. Engineering Survey: Engage a professional engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures as a result of removal and dismantling work.
- B. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs and [use of point cloud available from architect upon request].
 - 1. Comply with requirements specified in Section 013233 "Photographic Documentation."
- C. Perform surveys as the Work progresses to detect hazards resulting from historic removal and dismantling procedures.

3.04 HISTORIC REMOVAL AND DISMANTLING

- A. General: Have removal and dismantling work performed by a qualified historic removal and dismantling specialist. Ensure that historic removal and dismantling specialist's field supervisors are present when removal and dismantling work begins and during its progress.
- B. Perform work according to the historic treatment program and approved mockup(s).
 - 1. Perform removal and dismantling to the limits indicated.
 - 2. Provide supports or reinforcement for existing construction that becomes temporarily weakened by removal and dismantling work, until the Project Work is completed unless otherwise indicated.
 - 3. Perform cutting by hand or with small power tools wherever possible. Cut holes and slots neatly to size required, with minimum disturbance of adjacent work.
 - 4. Do not operate air compressors inside building unless approved by Architect in each case.
 - 5. Do not drill or cut columns, beams, joints, girders, structural slabs, or other structural supporting elements, without having Contractor's professional engineer's written approval for each location before such work is begun.
 - 6. Dispose of removed and dismantled items off-site unless indicated to be salvaged or reinstalled.
- C. Water-Mist Sprinkling: Use water-mist sprinkling and other wet methods to control dust only with adequate, approved procedures and equipment according to the historic treatment program to ensure that such water does not create a hazard or adversely affect other building areas or materials.
- D. Unacceptable Equipment: Keep equipment that is not permitted for historic removal or dismantling work away from the vicinity where such work is being performed.
- E. Removing and Dismantling Items on or Near Historic Surfaces:
 - 1. Use only dismantling equipment and procedures within 12 inches of historic surface. Do not use pry bars. Protect historic surface from contact with or damage by tools.
 - 2. Unfasten items in the opposite order from which they were installed.
 - 3. Support each item as it becomes loosened to prevent stress and damage to the historic surface.
 - 4. Dismantle anchorages.

- F. Anchorages:
 - 1. Remove anchorages associated with removed items.
 - 2. Dismantle anchorages associated with dismantled items.
 - 3. In non-historic surfaces, patch holes created by anchorage removal or dismantling according to the requirements for new work.
 - 4. In historic surfaces, patch or repair holes created by anchorage removal or dismantling according to Section that is specific to the historic surface being patched.

3.05 HISTORIC REMOVAL AND DISMANTLING SCHEDULE

- A. Existing Items to Be Removed: As Indicated on Drawings.
- B. Existing Items to Be Dismantled and Reinstalled:
 - 1. Historic interior window trim, as indicated on Drawings.
 - 2. Wood wainscot, as indicated on Drawings.
 - 3. Marble wainscot, as indicated on Drawings.
 - 4. Marble base, as indicated on Drawings.
 - 5. Vestibule light fixtures, as indicated on Drawings.
 - 6. Historic radiators, as indicated on Drawings.
 - 7. Other Items As Indicated on Drawings.
- C. Existing Items to Remain:
 - 1. Structural load-bearing concrete footings, foundations, and columns
 - 2. Structural load-bearing masonry walls.
 - 3. Structural steel trusses.
 - 4. Structural concrete floor and roof decks.
 - 5. Other items as indicated on Drawings.

END OF SECTION 024296

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**SECTION 031000
CONCRETE FORMING AND ACCESSORIES**

PART 2 PRODUCTS

1.01 FORMWORK - GENERAL

- A. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.
- B. Design and construct concrete that complies with design with respect to shape, lines, and dimensions.
- C. Comply with applicable state and local codes with respect to design, fabrication, erection, and removal of formwork.

END OF SECTION 031000

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SECTION 032000 CONCRETE REINFORCING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Reinforcing steel for cast-in-place concrete.
- B. Supports and accessories for steel reinforcement.

1.02 RELATED REQUIREMENTS

- A. Section 031000 - Concrete Forming and Accessories.
- B. Section 033000 - Cast-in-Place Concrete.
- C. Section 033713 - Shotcrete: Reinforcement for shotcrete.
- D. Section 042613 - Masonry Veneer: Spacing for veneer anchor reglets recessed in concrete.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 012200 - Unit Prices, for additional unit price requirements.
- B. Welded Wire Reinforcement: By the square foot (square m). Includes welded wire reinforcement, placement, and accessories.

1.04 REFERENCE STANDARDS

- A. ACI 301 - Specifications for Concrete Construction 2020.
- B. ACI 318 - Building Code Requirements for Structural Concrete 2019, with Errata (2021).
- C. ACI SP-66 - ACI Detailing Manual 2004.
- D. ASTM A184/A184M - Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement 2019.
- E. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2022.
- F. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire 2019.
- G. ASTM A704/A704M - Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement 2019, with Editorial Revision.
- H. ASTM A706/A706M - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement 2022.
- I. ASTM A767/A767M - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement 2019.
- J. ASTM A775/A775M - Standard Specification for Epoxy-Coated Steel Reinforcing Bars 2019.
- K. ASTM A884/A884M - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement 2019, with Editorial Revision (2020).
- L. ASTM A996/A996M - Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement 2016.
- M. ASTM A1035/A1035M - Standard Specification for Deformed and Plain, Low-Carbon, Chromium, Steel Bars for Concrete Reinforcement 2020.
- N. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2022.
- O. ASTM A1094/A1094M - Standard Specification for Continuous Hot-Dip Galvanized Steel Bars for Concrete Reinforcement 2020.
- P. ASTM D3963/D3963M - Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars 2021.
- Q. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification 2021.

- R. AWS D1.4/D1.4M - Structural Welding Code - Steel Reinforcing Bars 2018, with Amendment (2020).
- S. CRSI (DA4) - Manual of Standard Practice 2009.
- T. CRSI (P1) - Placing Reinforcing Bars, 10th Edition 2019.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Comply with requirements of ACI SP-66. Include bar schedules, shapes of bent bars, spacing of bars, and location of splices.
 - 1. Prepare shop drawings under seal of a Professional Structural Engineer experienced in design of work of this type and licensed in Utah.
- C. Manufacturer's Certificate: Certify that reinforcing steel and accessories supplied for this project meet or exceed specified requirements.
- D. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.
- E. Reports: Submit certified copies of mill test report of reinforcement materials analysis.

1.06 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301.
 - 1. Maintain one copy of each document on project site.
- B. Provide Architect with access to fabrication plant to facilitate inspection of reinforcement. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection.
- C. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.4/D1.4M and no more than 12 months before start of scheduled welding work.

PART 2 PRODUCTS

2.01 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi) (420 MPa) and Grade 80 (80,000 psi).
 - 1. Deformed billet-steel bars.
- B. Reinforcing Steel: ASTM A706/A706M, deformed low-alloy steel bars.
 - 1. Unfinished.
- C. Reinforcing Steel: Deformed bars, ASTM A996/A996M Grade 40 (280), Type A.
- D. Steel Welded Wire Reinforcement (WWR): Galvanized, deformed type; ASTM A1064/A1064M.
 - 1. Form: Flat Sheets.
 - 2. WWR Style: 4 x 8-W6 x W10 (102 x 203-MW39 x MW65).
- E. Reinforcement Accessories:
 - 1. Tie Wire: Annealed, minimum 16 gauge, 0.0508 inch (1.29 mm).
 - 2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.
 - 3. Provide stainless steel components for placement within 1-1/2 inches (38 mm) of weathering surfaces.

2.02 RE-BAR SPLICING:

- A. Coupler Systems: Mechanical devices for splicing reinforcing bars; capable of developing full steel reinforcing design strength in tension and compression.
 - 1. Products:
 - a. Dayton Superior Corporation; _____: www.daytonsuperior.com/#sle.
- B. Dowel Bar Splicer with Dowel-Ins: Mechanical devices for connecting dowels; capable of developing full steel reinforcing design strength in tension and compression.

1. Products:
 - a. Dayton Superior Corporation; _____: www.daytonsuperior.com/#sle.
- C. Grout: Cementitious, non-metallic, non-shrink grout for use with manufacturer's grout sleeve reinforcing bar coupler system.
 1. Products:
 - a. Dayton Superior Corporation; _____: www.daytonsuperior.com/#sle.

2.03 FABRICATION

- A. Fabricate concrete reinforcing in accordance with CRSI (DA4) - Manual of Standard Practice.
- B. Welding of reinforcement is permitted only with the specific approval of Architect. Perform welding in accordance with AWS D1.4/D1.4M.
 1. Galvanized Reinforcement: Clean surfaces, weld and re-protect welded joint in accordance with CRSI (DA4).
- C. Fabricate and handle epoxy-coated reinforcing in accordance with ASTM D3963/D3963M.
- D. Locate reinforcing splices not indicated on drawings at point of minimum stress.
 1. Review locations of splices with Engineer.

PART 3 EXECUTION

3.01 PLACEMENT

- A. Place, support and secure reinforcement against displacement. Do not deviate from required position.
- B. Do not displace or damage vapor barrier.
- C. Accommodate placement of formed openings.
- D. Maintain concrete cover around reinforcing as follows:
- E.
 1. As noted in structural drawings
- F. Comply with applicable code for concrete cover over reinforcement.
- G. Bond and ground all reinforcement to requirements of Section 260526.

3.02 FIELD QUALITY CONTROL

- A. An independent testing agency, as specified in Section 014000 - Quality Requirements, will inspect installed reinforcement for compliance with contract documents before concrete placement.

3.03 SCHEDULES

- A. Reinforcement For Superstructure Framing Members: Deformed bars, unfinished.
- B. Reinforcement For Foundation Wall Framing Members and Slab-on-Grade: Deformed bars and welded wire reinforcement, galvanized finish.

END OF SECTION 032000

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**SECTION 033000
CAST-IN-PLACE CONCRETE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Floors and slabs on grade.
- B. Joint devices associated with concrete work.
- C. Concrete curing.

1.02 RELATED REQUIREMENTS

- A. Section 031000 - Concrete Forming and Accessories: Forms and accessories for formwork.
- B. Section 032000 - Concrete Reinforcing.
- C. Section 071300 Sheet Water Proofing, for under slab waterproofing.
- D. Section 079200 - Joint Sealants: Products and installation for sealants and joint fillers for saw cut joints and isolation joints in slabs.

1.03 REFERENCE STANDARDS

- A. ACI 117 - Specification for Tolerances for Concrete Construction and Materials 2010 (Reapproved 2015).
- B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete 1991 (Reapproved 2009).
- C. ACI 211.2 - Standard Practice for Selecting Proportions for Structural Lightweight Concrete 1998 (Reapproved 2004).
- D. ACI 301 - Specifications for Concrete Construction 2020.
- E. ACI 302.1R - Guide to Concrete Floor and Slab Construction 2015.
- F. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete 2000 (Reapproved 2009).
- G. ACI 305R - Guide to Hot Weather Concreting 2020.
- H. ACI 306R - Guide to Cold Weather Concreting 2016.
- I. ACI 308R - Guide to External Curing of Concrete 2016.
- J. ACI 318 - Building Code Requirements for Structural Concrete 2019, with Errata (2021).
- K. ASTM C33/C33M - Standard Specification for Concrete Aggregates 2018.
- L. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens 2021.
- M. ASTM C150/C150M - Standard Specification for Portland Cement 2022.
- N. ASTM C157/C157M - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete 2017.
- O. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete 2020.
- P. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method 2016.
- Q. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete 2010a (Reapproved 2016).
- R. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete 2019.
- S. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete 2022.
- T. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete 2021.

- U. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures 2020.
- V. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete 2018.
- W. ASTM E1643 - Standard Practice for Selection, Design, Installation and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs 2018a.
- X. NSF 61 - Drinking Water System Components - Health Effects 2021.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
- C. Mix Design: Submit proposed concrete mix design.
 - 1. Indicate proposed mix design complies with requirements of ACI 301, Section 4 - Concrete Mixtures.
 - 2. Indicate proposed mix design complies with requirements of ACI 318, Chapter 5 - Concrete Quality, Mixing and Placing.
- D. Test Reports: Submit report for each test or series of tests specified.
- E. Sustainable Design Submittal: If any fly ash, ground granulated blast furnace slag, silica fume, rice hull ash, or other waste material is used in mix designs to replace Portland cement, submit the total volume of concrete cast in place, mix design(s) used showing the quantity of portland cement replaced, reports showing successful cylinder testing, and temperature on day of pour if cold weather mix is used.

PART 2 PRODUCTS

2.01 REINFORCEMENT MATERIALS

- A. Comply with requirements of Section 032000.

2.02 CONCRETE MATERIALS

- A. Cement: ASTM C150/C150M, Type I - Normal Portland type.
 - 1. Acquire cement for entire project from same source.
- B. Fine and Coarse Aggregates: ASTM C33/C33M.
 - 1. Acquire aggregates for entire project from same source.
- C. Fly Ash: ASTM C618, Class C or F.
- D. Calcined Pozzolan: ASTM C618, Class N.
- E. Silica Fume: ASTM C1240, proportioned in accordance with ACI 211.1.
- F. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

2.03 ADMIXTURES

- A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- B. Air Entrainment Admixture: ASTM C260/C260M.

2.04 ACCESSORY MATERIALS

2.05 BONDING AND JOINTING PRODUCTS

- A. Latex Bonding Agent: Non-redispersable acrylic latex, complying with ASTM C1059/C1059M, Type II.
 - 1. Products:
 - a. Euclid Chemical Company; AKKRO-7T: www.euclidchemical.com/#sle.
 - b. Kaufman Products Inc; SureBond: www.kaufmanproducts.net/#sle.
 - c. SpecChem, LLC; Strong Bond Acrylic Bonder: www.specchemllc.com/#sle.
 - d. W. R. Meadows, Inc; ACRY-LOK-: www.wrmeadows.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.

- B. Waterstops: Bentonite and butyl rubber.
 - 1. Configuration: As indicated on drawings.
 - 2. Products:
 - a. CETCO, a division of Minerals Technologies Inc; WATERSTOP RX:
www.mineralstech.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- C. Slab Isolation Joint Filler: 1/2 inch (13 mm) thick, height equal to slab thickness, with removable top section that will form 1/2 inch (13 mm) deep sealant pocket after removal.
- D. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with rectangular or round knockout holes for conduit or rebar to pass through joint form at 6 inches (150 mm) on center; ribbed steel stakes for setting.

2.06 CURING MATERIALS

- A. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound; complying with ASTM C309.
- B. Curing Agent, Water-Cure Equivalent Type: Clear, water-based, non-film-forming, liquid-water cure replacement agent.
 - 1. Comply with ASTM C309 standards for water retention.
 - 2. Comply with ASTM C309 standards for water retention.
 - 3. Compressive Strength of Treated Concrete: Equal to or greater than strength after 14-day water cure when tested according to ASTM C39/C39M.
 - 4. VOC Content: Zero.
 - 5. Products:
 - a. Substitutions: See Section 016000 - Product Requirements.

2.07 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
 - 1. Replace as much Portland cement as possible with fly ash, ground granulated blast furnace slag, silica fume, or rice hull ash as is consistent with ACI recommendations.
- B. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended or required by manufacturer.
- C. Normal Weight Concrete:
 - 1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 4,000 pounds per square inch (27.6 MPa).
 - 2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
 - 3. Calcined Pozzolan Content: Maximum 10 percent of cementitious materials by weight.
 - 4. Silica Fume Content: Maximum 5 percent of cementitious materials by weight.
 - 5. Water-Cement Ratio: Maximum 40 percent by weight.
 - 6. Total Air Content: 4 percent, determined in accordance with ASTM C173/C173M.
 - 7. Maximum Slump: 4 inches (100 mm).
 - 8. Maximum Aggregate Size: 3/4 inch (19 mm).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.02 PREPARATION

- A. Verify that forms are clean and free of rust before applying release agent.
- B. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in accordance with bonding agent manufacturer's instructions.
 - 1. Use latex bonding agent only for non-load-bearing applications.
- C. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.

- D. Interior Slabs on Grade: Install waterproof membrane under interior slabs on grade. Comply with ASTM E1643. Lap joints minimum 6 inches (150 mm). Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.
 - 1. Vapor Retarder/waterproofing membrane Over Granular Fill: Install compactible granular fill before placing vapor retarder as indicated on drawings. Do not use sand.

3.03 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Place concrete for floor slabs in accordance with ACI 302.1R.
- C. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
- D. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

3.04 SLAB JOINTING

- A. Locate joints as indicated on drawings.
- B. Anchor joint fillers and devices to prevent movement during concrete placement.
- C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
- D. Load Transfer Construction and Contraction Joints: Install load transfer devices as indicated; saw cut joint at surface as indicated for contraction joints.
- E. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch (5 mm) thick blade and cut at least 1 inch (25 mm) deep but not less than one quarter (1/4) the depth of the slab.
- F. Construction Joints: Where not otherwise indicated, use metal combination screed and key form, with removable top section for joint sealant.

3.05 FLOOR FLATNESS AND LEVELNESS TOLERANCES

- A. Maximum Variation of Surface Flatness:
 - 1. Exposed Concrete Floors: 1/4 inch (6 mm) in 10 feet (3 m).
 - 2. Under Seamless Resilient Flooring: 1/4 inch (6 mm) in 10 feet (3 m).
 - 3. Under Carpeting: 1/4 inch (6 mm) in 10 feet (3 m).
- B. Correct the slab surface if tolerances are less than specified.
- C. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

3.06 CONCRETE FINISHING

- A. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:
 - 1. Surfaces to Receive Thin Floor Coverings: "Steel trowel" as described in ACI 302.1R; thin floor coverings include carpeting, resilient flooring, seamless flooring, resinous matrix terrazzo, thin set quarry tile, and thin set ceramic tile.
 - 2. Other Surfaces to Be Left Exposed: Trowel as described in ACI 302.1R, minimizing burnish marks and other appearance defects.

3.07 CURING AND PROTECTION

- A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Surfaces Not in Contact with Forms:
 - 1. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.

2. Final Curing: Begin after initial curing but before surface is dry.

3.08 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
- C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
- D. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.

3.09 DEFECTIVE CONCRETE

- A. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.

END OF SECTION 033000

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**SECTION 033713
SHOTCRETE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pneumatically applied concrete.

1.02 RELATED REQUIREMENTS

- A. Section 032000 - Concrete Reinforcing.
- B. Section 033000 - Cast-in-Place Concrete: Reinforcement.
- C. Section _____: Control and expansion joint devices.
- D. Section 079200 - Joint Sealants: Sealing control and expansion joints.

1.03 REFERENCE STANDARDS

- A. ACI 506.2 - Specification for Shotcrete 2013 (Reapproved 2018).
- B. ASTM A884/A884M - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement 2019, with Editorial Revision (2020).
- C. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2022.
- D. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete 2018.
- E. ASTM C33/C33M - Standard Specification for Concrete Aggregates 2018.
- F. ASTM C150/C150M - Standard Specification for Portland Cement 2022.
- G. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete 2010a (Reapproved 2016).
- H. ASTM C330/C330M - Standard Specification for Lightweight Aggregates for Structural Concrete 2017a.
- I. ASTM C332 - Standard Specification for Lightweight Aggregates for Insulating Concrete 2017.
- J. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete 2019, with Editorial Revision (2022).
- K. COE CRD-C 48 - Handbook for Concrete and Cement Standard Test Method for Water Permeability of Concrete 1992.
- L. NSF 61 - Drinking Water System Components - Health Effects 2021.
- M. NSF 372 - Drinking Water System Components - Lead Content 2022.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Cooperate with artist performing sculpturing work.
- B. Preinstallation Meeting: Convene one week before starting work of this section.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on admixtures.
- C. Shop Drawings: Indicate formwork, and dimensions , reinforcement , accessories , and _____.
- D. Mix design test reports.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 506.2.
 - 1. Maintain one copy of document on site.

- B. Design work of this section under direct supervision of a Professional Structural Engineer experienced in design of shotcrete structures and licensed in Utah.
- C. Applicator Qualifications: Company specializing in performing shotcrete installations, with minimum _____ years of documented experience.
- D. Acceptable Applicators:
 - 1. _____.
 - 2. _____.

1.07 MOCK-UP

- A. Sample Panel: Provide mock-up of sufficient size to indicate special treatment or finish required.
- B. Test Panels: Prior to starting work provide mock-up for evaluation of materials and workmanship:
 - 1. Provide three test panels fabricated by placing shotcrete onto plywood for each mix design being considered, for each shooting position to be encountered, and for each _____ sq ft (_____ sq m) of placed shotcrete.
 - 2. Repair core holes after testing, in accordance with ACI 506.2.
- C. Locate mock-ups where directed.
- D. Mock-ups may remain as part of the Work.

1.08 FIELD CONDITIONS

- A. Maintain material and surrounding air temperature at minimum 50 degrees F (10 degrees C) prior to and during installation and maintain material at this minimum temperature for 7 days after completion of work. Provide equipment and cover to maintain minimum temperature.
- B. Suspend shotcrete operations during high winds, rainy weather, or near freezing temperatures when work cannot be protected.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cement: ASTM C150/C150M, Type I - Normal; white color.
- B. Aggregate: Normal weight, ASTM C33/C33M, 3/8 inch (9 mm) maximum size.
- C. Aggregate: Lightweight, ASTM C330/C330M.
- D. Aggregate: Insulating, ASTM C332.
- E. Admixtures: Chemical type complying with ASTM C494/C494M (wet mix only).
- F. Air-Entraining Admixture: Complying with ASTM C260/C260M (wet mix only).
- G. Waterproofing Admixture: Admixture formulated to reduce permeability to liquid water, with no adverse effect on concrete properties.
 - 1. Admixture Composition: Crystalline, functioning by growth of crystals in capillary pores.
 - 2. Potable Water Contact Approval: National Science Foundation (NSF) certification for use on structures holding potable water, based on testing in accordance with NSF 61 and NSF 372
- H. Reinforcing Bars: Type and size as indicated on drawings.
- I. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to shotcrete.
- J. Curing Compound: Water-based, spray-on, penetrating curing compound and hardener; not detrimental to application of subsequent surface finish materials; containing no wax, resin, or solvents.
 - 1. Manufacturers:
 - a. W. R. Meadows, Inc; Deck-O-Treat: www.wrmeadows.com/#sle.
- K. Bonding Agent: _____ type; Compatible with substrate and subsequent materials.
- L. Alignment Wire: Small gauge, high strength steel wire.

2.02 SHOTCRETE MIX

- A. Provide wet or dry mix design that gives good compaction and low percentage of rebound, is stiff enough not to sag.
- B. Comply with following requirements:
 - 1. Compressive Strength (28 day minimum): As noted on structural drawings
 - 2. Aggregate Size (maximum): 3/8 inch (9 mm).
- C. Maintain quality control records during production of shotcrete; make records available.

2.03 EQUIPMENT

- A. Mixing Equipment: Capable of thoroughly mixing aggregate, cement, and water in sufficient quantity to maintain continuous placement.
- B. Delivery Equipment: Capable of discharging wet mix aggregate, cement, and water accurately, uniformly, and continuously.
- C. Water Supply: Uniform water pressure at discharge nozzle sufficiently greater than operating air pressure to ensure intimate mixing with aggregate-cement mix; provide water pump to system if line water pressure is inadequate.

2.04 SOURCE QUALITY CONTROL

- A. An independent testing agency will provide inspection and testing services, as specified in Section 014000 - Quality Requirements.
- B. Prior to start of work, testing agency will review mix proportions, gradation, and quality of aggregate.
- C. Provide inspection for compliance with design mix.
- D. Test samples in accordance with ACI 506.2.
- E. Independent testing agency will test mock-up panels as follows:
 - 1. Drill 3 inch (75 mm) diameter core samples from test panels.
 - 2. Test for strength.
- F. Modify mix design as required based on results of testing.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that conditions are acceptable and are ready to receive work.
- C. Verify that field measurements are as indicated on drawings.
- D. Verify fabricated forms are:
 - 1. True to line and dimension.
 - 2. Adequately braced against vibration during placement.
 - 3. Constructed to permit escape of trapped air during gunning operations.
- E. Verify correct placement of reinforcement with sufficient clearances to permit complete encasement.
- F. Verify that embedded fittings, pipe, conduits, and other items are correctly and securely placed.
- G. Ensure easy access to shotcrete surfaces for screeding and finishing, and to permit uninterrupted application.

3.02 PREPARATION

- A. Remove existing unsound concrete and existing unsound masonry from substrate surfaces.
 - 1. Minimize abrupt changes in depth of area to be repaired.
 - 2. Remove square external corners from substrate by radiusing the edges.
- B. Sandblast surfaces to receive shotcrete.

- C. Determine operating procedures for placement in close quarters, extended distances, or around unusual obstructions where placement velocities and mix consistency may be adjusted during application.
- D. Clean and wet cementitious or absorptive substrate surfaces prior to receiving shotcrete. Keep porous surfaces damp for several hours prior to placement of shotcrete.
- E. Apply bonding agent.
- F. Protect adjacent surfaces not receiving shotcrete.

3.03 ALIGNMENT CONTROL

- A. Provide alignment wire to establish thickness and plane of required surfaces.
- B. Install alignment wire at corners and offsets not established by forms.
- C. Tighten alignment wire true to line. Position adjustment devices to permit additional tightening.

3.04 APPLICATION

- A. Place reinforcement in accordance with ACI 506.2.
- B. Use mixing and delivery equipment capable of thoroughly mixing aggregate, cement, and water in sufficient quantity to maintain continuous and uniform placement.
- C. Do not apply shotcrete more than 45 minutes after adding Portland cement to the mix.
- D. Do not place shotcrete on surfaces that are frozen, spongy, or where there is free water.
- E. Achieve maximum compaction with minimum rebound.
- F. Build-up to required thickness in multiple passes to achieve layering. Encase reinforcement with the first pass.
- G. Allow each layer to take initial set before applying succeeding layers.
- H. Do not permit applied shotcrete to sag, slough, or displace.
- I. After initial set of final layer, remove excess material outside of forms and alignment lines.
- J. Sandblast to remove laitance. Clean with air/water pressure jet.
- K. Finish surface of final layer with natural gun finish.
- L. Remove rebound material that does not fall clear of work; discard salvaged rebound.
- M. Immediately after placement, protect shotcrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- N. Maintain surfaces wet for a minimum of 7 days.
- O. Apply curing compound to exposed surfaces according to manufacturer's instructions.
- P. Sound test the applied material with hammer for voids. Expose voids and replace with new shotcrete ensuring full bond with adjacent work.

3.05 FIELD QUALITY CONTROL

- A. Provide additional test panels, as specified for mock-up, during the course of the work as may be requested by the testing agency.
- B. In-Place Shotcrete: Take a set of 3 unreinforced cores for each mix and for each workday or for every 50 cu. yd. of shotcrete placed; whichever is less. Test cores for compressive strength according to ACI 506.2 and ASTM C 42. Do not cut steel reinforcement.
- C. Strength of shotcrete will be considered satisfactory when mean compressive strength of each set of 3 unreinforced cores equals or exceeds 85 percent of specified compressive strength, with no individual core less than 75 percent of specified compressive strength.
- D. Mean compressive strength of each set of 3 unreinforced cubes shall equal or exceed design compressive strength with no individual cube less than 88 percent of specified compressive strength.

3.06 PROTECTION

- A. Do not permit applied work to damage adjacent surfaces.

END OF SECTION 033713

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**SECTION 040342
HISTORIC STONE MASONRY REPAIR**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes historic treatment work consisting of repairing historic stone assemblies as follows:
 - 1. Repairing stone masonry.
 - 2. Removing abandoned anchors.
- B. Related Requirements:
 - 1. Section 013591 "Historic Treatment Procedures" for general historic treatment requirements.
 - 2. Section 024296 "Historic Removal and Dismantling" for historic removal and dismantling work.

1.03 DEFINITIONS

- A. Low-Pressure Spray:
 - 1. Pressure: 100 to 400 psi.
 - 2. Flow Rate: 4 to 6 gpm.
- B. Face Bedding: Setting of stone with the rift or natural bedding planes (strata) vertical and parallel to the wall plane rather than horizontal or "naturally bedded," which holds bedding planes together by gravity.
- C. Rebuilding (Setting) Mortar: Mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.
- D. Rift: The most pronounced direction of splitting or cleavage of a stone.
- E. Stone Terminology: ASTM C119.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference on historic masonry repair and repointing at Project site.
 - 1. Review methods and procedures related to repairing historic stone masonry, including, but not limited to, the following:
 - a. Verify historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.
 - c. Quality-control program.
 - d. Fire-protection plan.
 - e. Stone historic treatment program.
 - f. Coordination with building occupants.

1.05 SEQUENCING AND SCHEDULING

- A. Order sand and gray portland cement for colored mortar immediately after approval of mockups. Take delivery of and store at Project site a sufficient quantity to complete Project.
- B. Work Sequence: Perform stone historic treatment work in the following sequence, which includes work specified in this and other Sections:
 - 1. Remove paint.
 - 2. Clean stone.
 - 3. Rake out mortar from joints surrounding stone to be replaced and from joints adjacent to stone repairs along joints.

4. See Section 024296 "Historic Removal and Dismantling" for historic removal and dismantling work.
5. Repair stonework, including replacing existing stone with new stone. If required, repair backup masonry.
6. Rake out mortar from joints to be repointed.
7. Point mortar and sealant joints.
8. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.

1.06 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 recommendations for product application and use.
 3. Include test data substantiating that products comply with requirements.
- B. Shop Drawings:
 1. Include plans, elevations, sections, and locations of stone repair work on the structure.
 2. Indicate complete dimensions for new stone units and their jointing, showing relation of existing to new units.
 3. Show partial replacement stone units (dutchmen).
 4. Indicate setting number of each new stone unit and its location on the structure in annotated plans and elevations.
 5. Show provisions for expansion joints or other sealant joints.
 6. Show provisions for flashing, lighting fixtures, conduits, and weep holes as required.
 7. Show replacement and repair anchors, including drilled-in pins. Include details of anchors within individual stone units, with locations of anchors and dimensions of holes and recesses in stone required for anchors, including direction and angle of holes for pins.
 8. Show locations of scaffolding and points of scaffolding in contact with masonry. Include details of each point of contact or anchorage.
- C. Samples for Initial Selection: For the following:
 1. Colored Mortar: Submit sets of mortar that will be left exposed in the form of sample mortar strips, 6 inches long by 1/4 inch wide, set in aluminum or plastic channels.
 - a. Have each set contain a close color range of at least three Samples of different mixes of colored sands and cements that produce a mortar matching existing, cleaned mortar when cured and dry.
 - b. Submit with precise measurements on ingredients, proportions, gradations, and sources of colored sands from which each Sample was made.
 2. Each type of sand used for mortar; minimum 8 oz. of each in plastic screw-top jars.
 - a. For blended sands, provide Samples of each component and blend. Identify blend ratio.
 - b. Identify sources, both supplier and quarry, of each type of sand.
 3. Patching Compound: Submit sets of patching compound Samples in the form of plugs (patches in drilled holes) in sample units of stone representative of the range of stone colors on the building.
 - a. Have each set contain a close color range of at least three Samples of different mixes of patching compound that matches the variations in existing stone when cured and dry.
 4. Include similar Samples of accessories involving color selection.
- D. Samples for Verification: For the following:
 1. Each type of replacement stone. Include sets of Samples to show full range of color, texture, grain, veining, and finish to be expected. Provide sets of at least three 12-by-12-inch Samples for each type, but no fewer than necessary to indicate full range and the proportion of variations within range.
 2. Each type of patching compound in form of briquettes, at least 3 inches long by 1-1/2 inches wide. Document each Sample with manufacturer and stock number or other

information necessary to order additional material.

1.07 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For historic treatment specialist.
- B. Stone historic treatment program.

1.08 QUALITY ASSURANCE

- A. Historic Treatment Specialist Qualifications: A qualified historic stone repair specialist. Experience installing standard unit masonry or new stone masonry is insufficient experience for stone historic treatment work.
- B. Stone Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for each phase of the historic treatment work, including protection of surrounding materials and Project site.
 - 1. Include methods for keeping exposed mortar damp during curing period.
 - 2. If materials and methods other than those indicated are proposed for any phase of historic treatment work, add to the quality-control program a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.
- C. Mockups: Prepare mockups of historic treatment to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation.
 - 1. Stone Repair: Prepare sample areas for each type of stone indicated to have repair work performed. If not otherwise indicated, size each mockup not smaller than two adjacent whole units or approximately 48 inches in least dimension. Construct sample areas in locations in existing walls where directed by Architect unless otherwise indicated. Demonstrate quality of materials, workmanship, and blending with existing work. Include the following as a minimum:
 - a. Replacement: Four stone units replaced.
 - b. Partial Stone Replacement: Two partial stone replacements (dutchman repairs).
 - c. Stone Plug Repair: Two stone plug repairs for each type of stone indicated to be plugged.
 - d. Crack Injection: Apply crack injection in two separate areas, each approximately 36 inches long.
 - e. Patching: Three small holes at least 1 inch in diameter for each type of stone indicated to be patched, so as to leave no evidence of repair.
 - 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.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver stone to Project site strapped together in suitable packs or pallets or in heavy-duty crates and protected against impact and chipping.
- B. Deliver each piece of stone with code mark or setting number on unexposed face, corresponding to Shop Drawings, using nonstaining paint.
- C. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.
- D. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- E. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.
- F. Store lime putty covered with water in sealed containers.
- G. Store sand where grading and other required characteristics can be maintained and contamination avoided.

- H. Handle stone to prevent overstressing, chipping, defacement, and other damage.

1.10 FIELD CONDITIONS

- A. Temperature Limits: Repair stonework only when air temperature is between 40 and 90 deg F and is predicted to remain so for at least seven days after completion of the Work unless otherwise indicated.
- B. Cold-Weather Requirements: Comply with the following procedures for stone repair unless otherwise indicated:
 - 1. When air temperature is below 40 deg F, heat mortar ingredients, repair materials, and existing stone to produce temperatures between 40 and 120 deg F.
 - 2. When mean daily air temperature is below 40 deg F, provide enclosure and heat to maintain temperatures above 32 deg F within the enclosure for seven days after repair.
- C. Hot-Weather Requirements: Protect stonework repairs when temperature and humidity conditions produce excessive evaporation of water from mortar and patching materials. Provide artificial shade and wind breaks, and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90 deg F and above unless otherwise indicated.
- D. For manufactured repair materials, perform work within the environmental limits set by each manufacturer.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Source Limitations: Obtain each type of material for repairing historic masonry (stone, cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.02 MASONRY MATERIALS

- A. Stone Matching Existing: Natural building stone of variety, color, texture, grain, veining, finish, size, and shape that match existing stone and with physical properties
 - 1. For existing stone that exhibits a range of colors, textures, grains, veining, finishes, sizes, or shapes, provide stone that proportionally matches that range rather than stone that matches an individual color, texture, grain, veining, finish, size, or shape within that range.
 - 2. Quarry: Subject to compliance with requirements, provide stone from the original quarry.
 - a. Original Quarry, Cedar and Light Rose: Tennessee Marble Co., Brown quarry, Friendsville, Tennessee.
- B. Stone Matching Architect's Sample: Natural building stone of variety, color, texture, grain, veining, finish, and physical properties that match Architect's sample. Match existing stone in size and shape.
 - 1. For Architect's sample that exhibits a range of colors, textures, grains, veining, finishes, sizes, or shapes, provide stone that proportionally matches that range rather than stone that matches an individual color, texture, grain, veining, finish, size, or shape within that range.
- C. Quarrying New Stone: Have quarry clearly label the direction of rift or bedding planes when rough stone is quarried, to facilitate cutting stones so that natural bedding planes are as required in "Cutting New Stone" Paragraph.
- D. Cutting New Stone: Regardless of how existing stone was cut and set, cut each new stone so that, when it is set in final position, the rift or natural bedding planes match the rift orientation of existing stones.
- E. Date Identification: Stamp with permanent, nonbleeding ink on a concealed, interior surface of each new stone in easily read 1/4-inch-high characters, "MADE [year]."
- F. Salvaged Stone: Obtain from location indicated on Drawings. Clean off residual mortar.
- G. Building Brick: Brick having same vertical dimension as existing backup brick, according to ASTM C62, Grade SW, MW, or NW.

2.03 MORTAR MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or Type II; white or gray, or both, where required for color matching of mortar.
 - 1. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Mortar Sand: ASTM C144 unless otherwise indicated.
 - 1. Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
- D. Water: ASTM C270, potable.

2.04 MANUFACTURED REPAIR MATERIALS

- A. Stone-Patching Compound: Factory-mixed cementitious product that is custom manufactured for patching stone.
 - 1. Use formulation that is vapor and water permeable (equal to or more than the stone), exhibits low shrinkage, has lower modulus of elasticity than the stone units being repaired, and develops high bond strength to all stone types.
 - 2. Use formulation having working qualities and retardation control to permit forming and sculpturing where necessary.
 - 3. Formulate patching compound in colors, textures, and grain to match stone being patched. Provide no fewer than three colors to enable matching each piece of stone.
- B. Cementitious Crack Filler: Ultrafine superplasticized grout that can be injected into cracks, is suitable for application to wet or dry cracks, exhibits low shrinkage, and develops high bond strength to all stone types.
- C. Stone-to-Stone Adhesive: Two-part polyester stone adhesive with a 15- to 45-minute cure at 70 deg F, recommended in writing by adhesive manufacturer for type of stone repair indicated, and matching stone color.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Wood & Stone Company, Transparent Knife Grade Polyester Stone Adhesive.

2.05 ACCESSORY MATERIALS

- A. Stone Anchors: Type and size indicated or, if not indicated, to match existing anchors in size and type. Fabricate from Type 304 stainless steel.
- B. Setting Buttons and Shims: Resilient plastic, nonstaining to stone, sized to suit joint thicknesses and bed depths of stone units, less the required depth of pointing materials unless removed before pointing.
- C. Masking Tape: Nonstaining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.
- D. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
 - 1. Previous effectiveness in performing work involved.
 - 2. Minimal possibility of damaging exposed surfaces.
 - 3. Consistency of each application.
 - 4. Uniformity of the resulting overall appearance.
 - 5. Do not use products or tools that could do the following:
 - a. Remove, alter, or harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in contract.
 - b. Leave residue on surfaces.

2.06 MORTAR MIXES

- A. Preparing Lime Putty: Slake quicklime and prepare lime putty according to appendix in ASTM C5 and to manufacturer's written instructions.

- B. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.
- C. Colored Mortar: Produce mortar of color required by using specified ingredients. Do not alter specified proportions without Architect's approval.
- D. Do not use admixtures in mortar unless otherwise indicated.
- E. Mixes: Mix mortar materials in the following proportions:
 - 1. Rebuilding (Setting) Mortar by Type: ASTM C270, Proportion Specification, Type N unless otherwise indicated; with cementitious material limited to portland cement and lime.
 - 2. Colored Mortar: Add mortar pigments to produce exposed, setting (rebuilding) mortar of colors required.

PART 3 EXECUTION

3.01 PROTECTION

- A. Prevent mortar from staining face of surrounding stone and other surfaces.
 - 1. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
 - 2. Keep wall area wet below rebuilding and repair work to discourage mortar from adhering.
 - 3. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.

3.02 STONE REPAIR, GENERAL

- A. Have repair work performed only by qualified historic treatment specialist.

3.03 ABANDONED ANCHOR REMOVAL

- A. Remove abandoned anchors, brackets, wood nailers, and other extraneous items no longer in use unless indicated to remain.
 - 1. Remove items carefully to avoid spalling or cracking stone.
 - 2. Notify Architect before proceeding if an item cannot be removed without damaging surrounding stone; do the following where directed:
 - a. Cut or grind off item approximately 3/4 inch beneath surface, and core drill a recess of same depth in surrounding stone as close around item as practical.
 - b. Immediately paint exposed end of item with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended dry film thickness per coat. Keep paint off sides of recess.
 - 3. Patch the hole where each item was removed unless directed to remove and replace the stone unit.

3.04 STONE REMOVAL AND REPLACEMENT

- A. At locations indicated, remove stone that has deteriorated or is damaged beyond repair or is to be reused. Carefully remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full-size units.
- B. Support and protect remaining masonry that was supported by removed stone.
- C. Notify Architect of unforeseen detrimental conditions, including voids, cracks, bulges, loose masonry units in existing stone or unit masonry backup, rotted wood, rusted metal, and other deteriorated items.
- D. Remove in an undamaged condition as many whole stone units as possible.
 - 1. Remove mortar, loose particles, and soil from stone by cleaning with hand chisels, brushes, and water.
 - 2. Remove sealants by cutting close to stone with utility knife and cleaning with solvents.
 - 3. Store stone for reuse. Store off ground, on skids, and protected from weather.
 - 4. Deliver cleaned stone not required for reuse to Owner unless otherwise indicated.
- E. Clean masonry surrounding removal areas by removing mortar, dust, and loose particles in preparation for stone replacement.
- F. Replace removed damaged stone with other removed stone and salvaged stone in good condition, where possible, or with new stone matching existing stone. Do not use broken units

unless they can be adhered using polyester adhesive.

- G. Rift: Do not allow face bedding of stone. Before setting, inspect to verify that each stone has been cut so that, when it is set in final position, the rift or natural bedding planes are predominantly horizontal. Reject stone with vertical bedding planes, except as required for arches, lintels, and copings.
- H. Install replacement stone into bonding and coursing pattern of existing stone. If cutting is required, use a motor-driven saw designed to cut stone with clean, sharp, unchipped edges. Finish edges to blend with appearance of edges of existing stone.
 - 1. Maintain joint width for replacement stone to match existing joints.
 - 2. Use setting buttons or shims to set stone accurately spaced with uniform joints.
- I. Set replacement stone with rebuilding (setting) mortar and with completely filled bed, head, and collar joints. Butter vertical joints for full width before setting, and set units in full bed of mortar unless otherwise indicated. Replace existing anchors with new anchors of size and type indicated.
 - 1. Tool exposed mortar joints in repaired areas to match joints of surrounding existing stonework.
 - 2. When mortar is hard enough to support units, remove shims and other devices interfering with pointing of joints.
- J. Curing: Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.
 - 1. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

3.05 BACKUP MASONRY REMOVAL AND REPLACEMENT

- A. Where backup masonry is fractured or unstable and at locations indicated, remove mortar and masonry units that are broken or deteriorated, and rebuild with whole, new brick or whole, salvaged backup masonry units. Carefully remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full-size units.
- B. Support and protect remaining masonry that surrounds removal area.
- C. Notify Architect of unforeseen detrimental conditions, including voids, cracks, bulges, loose masonry units beyond the removal area, rotted wood, rusted metal, and other deteriorated items.
- D. Remove in an undamaged condition as many whole bricks as possible.
 - 1. Remove mortar, loose particles, and soil from brick by cleaning with hand chisels, brushes, and water.
 - 2. Remove sealants by cutting close to brick with utility knife and cleaning with solvents.
 - 3. Store brick for reuse. Store off ground, on skids, and protected from weather.
 - 4. Deliver cleaned brick not required for reuse to Owner unless otherwise indicated.
- E. Clean masonry surrounding removal areas by removing mortar, dust, and loose particles in preparation for brick replacement.
- F. Replace removed damaged brick with salvaged backup brick in good condition, where possible, or with new building brick matching existing backup brick. Do not use broken units unless they can be cut to usable size.
- G. Install replacement brick into bonding and coursing pattern of existing brick. If cutting is required, use a motor-driven saw designed to cut masonry with clean, sharp, unchipped edges.
- H. Lay replacement brick with rebuilding (setting) mortar and with completely filled bed, head, and collar joints. Butter ends with sufficient mortar to fill head joints and shove into place. Wet both replacement and surrounding bricks that have ASTM C67 initial rates of absorption (suction) of more than 30 g/30 sq. in. per min.. Use wetting methods that ensure that units are nearly saturated but surface is dry when laid.
- I. Curing: Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.

1. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

3.06 PARTIAL STONE REPLACEMENT

- A. Remove defective portion of existing stone unit (backing stone). Carefully remove defective portion of stone by making vertical and horizontal saw cuts at face of backing stone and removing defective material to depth required for fitting partial replacement (dutchman).
 1. Make edges of backing stone at cuts smooth and square to each other and to finished surface; essentially rectangular. Make back of removal area flat and parallel to stone face.
 2. Do not overcut at corners and intersections. Hand trim to produce clean sharp corners with no rounding and no damage to existing work to remain.
 3. If backing stone becomes further damaged, remove damaged area and enlarge partial replacement as required.
- B. Remove mortar from joints that abut area of stone removal to same depth as stone was removed. Remove loose mortar particles and other debris from surfaces to be bonded and surfaces of adjacent stone units that will receive mortar by cleaning with stiff-fiber brush.
- C. Cut and trim partial replacement to accurately fit area where material was removed from backing stone. Fabricate to size required to produce joints between partial replacement and backing stone of no more than 1/16 inch in width, and to produce joints between partial replacement and other stones that match existing joints between stones. Cut partial replacement so that, when it is set in final position, natural bedding planes match the orientation of bedding planes of the backing stone unless otherwise indicated.
- D. Pinning: Before applying adhesive, prepare for mechanical anchorage consisting of 1/4-inch-diameter, plain stainless-steel pins set into 1/4-inch-diameter holes drilled at a 45-degree downward angle through face of partial replacement and into backing stone.
 1. Center and space pins between 3 and 5 inches apart and at least 2 inches from any edge. Insert pins at least 2 inches in backing stone and 2 inches in partial replacement, with end countersunk at least 3/4 inch from exposed face of partial replacement.
- E. Apply stone-to-stone adhesive according to adhesive manufacturer's written instructions. Coat bonding surfaces of backing stone and partial replacement, completely filling all crevices and voids.
- F. Apply partial replacement while adhesive is still tacky, and hold securely in place until adhesive has cured. Use shims, clamps, wedges, or other devices as necessary to align face of partial replacement with face of backing stone.
- G. Clean adhesive residue from exposed surfaces and patch chipped areas and exposed drill holes as specified in "Stone Patching" Article.

3.07 STONE PLUG REPAIR

- A. Remove cylindrical piece of damaged stone by core-drilling perpendicular to stone surface.
- B. Prepare a replacement plug by core-drilling replacement stone. Use a drill sized to produce a core that fits into hole drilled in damaged stone, with only minimum gap necessary for adhesive. Cut and install plug so that, when it is set in final position, natural bedding planes match the orientation of bedding planes of the backing stone unless otherwise indicated.
- C. Apply stone-to-stone adhesive according to adhesive manufacturer's written instructions. Coat bonding surfaces of existing stone and plug, completely filling all crevices and voids.
- D. Apply plug flush with surrounding stone while adhesive is still tacky, and hold securely in place until adhesive has cured.
- E. Clean adhesive residue from exposed surfaces.

3.08 STONE-FRAGMENT REPAIR

- A. Carefully remove cracked or fallen stone fragment indicated to be repaired. Reuse only stone fragment that is in sound condition.
- B. Remove soil, loose particles, mortar, and other debris or foreign material from fragment surfaces to be bonded and from parent stone where fragment had broken off, by cleaning with

stiff-fiber brush.

- C. Pinning: Before applying adhesive, prepare for mechanical anchorage consisting of 1/4-inch-diameter, plain stainless-steel pins set into 1/4-inch-diameter holes drilled at a 45-degree downward angle through face of fragment and into parent stone.
 - 1. Center and space pins 3 to 5 inches apart and at least 2 inches from any edge. Insert pins at least 2 inches in parent stone and 2 inches in fragment, with end countersunk at least 3/4 inch from exposed face of fragment.
- D. Apply stone-to-stone adhesive according to adhesive manufacturer's written instructions. Coat bonding surfaces of fragment and parent stone, completely filling all crevices and voids.
- E. Fit stone fragment onto parent stone while adhesive is still tacky, and hold fragment securely in place until adhesive has cured. Use shims, clamps, wedges, or other devices as necessary to align face of fragment with face of parent stone.
- F. Clean adhesive residue from exposed surfaces and patch chipped areas and exposed drill holes as specified in "Stone Patching" Article.

3.09 CRACK INJECTION

- A. General: Comply with cementitious crack-filler manufacturer's written instructions.
- B. Drill 1/4-inch-diameter injection holes as follows:
 - 1. Transverse Cracks Less Than 3/8 inch Wide: Drill holes through center of crack at 12 to 18 inches o.c.
 - 2. Transverse Cracks More Than 3/8 inch Wide: Drill holes through center of crack at 18 to 36 inches o.c.
 - 3. Delaminations: Drill holes at approximately 18 inches o.c., both vertically and horizontally.
 - 4. Drill holes 2 inches deep.
- C. Clean out drill holes and cracks with compressed air and water. Remove dirt and organic matter, loose material, sealants, and failed crack repair materials.
- D. Place plastic injection ports in drilled holes, and seal face of cracks between injection ports with clay or other nonstaining, removable plugging material. Leave openings at upper ends of cracks for air release.
- E. Inject cementitious crack filler through ports sequentially, beginning at one end of area and working to opposite end; where possible, begin at lower end of injection area and work upward. Inject filler until it extrudes from adjacent ports. After port has been injected, plug with clay or other suitable material, and begin injecting filler at adjacent port, repeating process until all ports have been injected.
- F. Clean cementitious crack filler from face of stone before it sets, by scrubbing with water.
- G. After cementitious crack filler has set, remove injection ports, plugging material, and excess filler. Patch injection holes and surface of cracks as specified in "Stone Patching" Article.

3.10 STONE PATCHING

- A. Patch the following stone units unless another type of repair or replacement is indicated:
 - 1. Units indicated to be patched.
 - 2. Units with holes.
 - 3. Units with chipped edges or corners. Patch chipped edges or corners measuring more than 3/4 inch in least dimension.
 - 4. Units with small areas of deep deterioration. Patch deep deteriorations measuring more than 3/4 inch in least dimension and over 1/4 inch deep.
- B. Remove and replace existing patches where indicated.
- C. Remove deteriorated material, and remove adjacent material that has begun to deteriorate. Carefully remove additional material so patch does not have feathered edges but has square or slightly undercut edges on area to be patched and is at least 1/4 inch thick, but not less than as recommended in writing by patching compound manufacturer.
- D. Mask adjacent mortar joint or rake out for repointing if patch extends to edge of stone unit.

- E. Mix patching compound in individual batches to match each stone unit being patched. Combine one or more colors of patching compound, as needed, to produce exact match.
- F. Brush-coat stone surfaces with slurry coat of patching compound according to manufacturer's written instructions.
- G. Place patching compound in layers as recommended in writing by patching compound manufacturer, but not less than 1/4 inch or more than 2 inches thick. Roughen surface of each layer to provide a key for next layer.
 - 1. Simple Details: Trowel, scrape, or carve surface of patch to match texture and surrounding surface plane or contour of the stone. Shape and finish surface before or after curing, as determined by testing, to best match existing stone.
 - 2. Carved Details: Build patch up 1/4 inch above surrounding stone, and carve surface to match adjoining stone after patching compound has hardened.
- H. Keep each layer damp for 72 hours or until patching compound has set.
- I. Remove and replace patches with hairline cracks or that show separation from stone at edges, and those that do not match adjoining stone in color or texture.

3.11 FINAL CLEANING

- A. After mortar has fully hardened, thoroughly clean exposed stone surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water applied by low-pressure spray.
 - 1. Do not use metal scrapers or brushes.
 - 2. Do not use acidic or alkaline cleaners.
- B. Clean adjacent nonstone surfaces. Use detergent and soft brushes or cloths.
- C. Remove masking materials, leaving no residues that could trap dirt.
- D. Sweep and rake adjacent pavement and grounds to remove mortar and debris. Where necessary, pressure-wash pavement surfaces to remove mortar, dust, dirt, and stains.

3.12 STONE-WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess stone materials are Contractor's property.
- B. Stone Waste: Remove stone waste and legally dispose of off Owner's property.

END OF SECTION 040342

**SECTION 050371
HISTORIC DECORATIVE METAL CLEANING**

PART 1 GENERAL

2.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

2.02 SUMMARY

- A. Section includes historic treatment of decorative metal in the form of cleaning as follows:
 - 1. Cleaning metal.
 - 2. Removing paint.
 - 3. Removing corrosion.
 - 4. Priming for repainting.
- B. Related Requirements:
 - 1. Section 013591 "Historic Treatment Procedures" for general historic treatment requirements.

2.03 DEFINITIONS

- A. Low-Pressure Spray:
 - 1. Pressure: [100 to 400 (690 to 2750)] psi (kPa).
 - 2. Flow Rate: [4 to 6 (0.25 to 0.4)] gpm (L/s).
- B. Medium-Pressure Spray:
 - 1. Pressure: [400 to 800 (2750 to 5510)] psi (kPa).
 - 2. Flow Rate: [4 to 6 (0.25 to 0.4)] gpm (L/s).
- C. High-Pressure Spray:
 - 1. Pressure: [800 to 1200 (5510 to 8250)] psi (kPa).
 - 2. Flow Rate: [4 to 6 (0.25 to 0.4)] gpm (L/s).

2.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] .
 - 1. Review minutes of Preliminary Historic Treatment Conference that pertain to historic treatment of decorative metal.
 - 2. Review methods and procedures related to historic treatment of decorative metal including, but not limited to, the following:
 - a. Verify historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, and sequencing.
 - c. Fire-protection plan.
 - d. Decorative metal historic treatment program.
 - e. Coordination with building occupants.

2.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include recommendations for product application and use.
 - 2. Include test data substantiating that products comply with requirements.

2.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For [historic treatment specialist] [chemical-cleaner manufacturer] [paint-remover manufacturer].
- B. Decorative Metal Historic Treatment Program: For cleaning historic decorative metalwork.

- C. Preconstruction Test Reports: For [chemical cleaning of] [and] [paint removal from] historic decorative metal.

2.07 QUALITY ASSURANCE

- A. Historic Treatment Specialist Qualifications: A qualified historic decorative metal cleaning specialist. Cleaning specialist shall be experienced in using mechanical and chemical methods on the types of metal surfaces indicated.
 - 1. Single Specialist: Have the work of [this Section] [Section 050372 "Historic Decorative Metal Repair"] [Section 050373 "Historic Decorative Metal Refinishing"] [Section 050374 "Historic Decorative Metal Replication"] [and] [Section 050383 "Historic Cast Iron Repair"] performed by the same historic treatment specialist firm, meeting the specialist qualifications of those Sections.
- B. Chemical-Cleaner Manufacturer Qualifications: A firm regularly engaged in producing metal cleaners that have been used for similar historic decorative metal applications with successful results and with factory-authorized service representatives who are available for consultation and Project-site inspection[, preconstruction product testing,] and on-site assistance.
- C. Paint-Remover Manufacturer Qualifications: A firm regularly engaged in producing paint removers that have been used for similar historic decorative metal applications with successful results and with factory-authorized service representatives who are available for consultation and Project-site inspection[, preconstruction product testing,] and on-site assistance.
- D. Decorative Metal Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for historic treatment work, including each process or phase of cleaning decorative metal, related work, and the protection of surrounding materials and Project site.
 - 1. If materials and methods other than those indicated are proposed for any phase of historic treatment work, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.
- E. Mockups: Prepare mockups of historic treatment cleaning processes[on existing surfaces] to demonstrate aesthetic effects and to set quality standards for materials and execution. Prepare mockups so they are inconspicuous.
 - 1. Cleaning: Prepare an area [approximately 2 sq. ft. (0.2 sq. m)] [as indicated on Drawings] for each process on each type of metal indicated for treatment.
 - 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.

2.08 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified historic treatment specialist or one or more [chemical-cleaner] [and] [paint-remover] manufacturers to perform preconstruction testing on each type of historic metal.
 - 1. Use test areas as indicated and representative of proposed materials and existing construction.
 - 2. Propose changes to materials and methods to suit Project.

2.09 FIELD CONDITIONS

- A. Weather Limitations: Proceed with historic treatment of decorative metal only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 PRODUCTS

3.01 CLEANING MATERIALS

- A. Water: Potable.

- B. Hot Water: Water heated to a temperature of 140 to 160 deg F (60 to 71 deg C).
- C. Detergent Solution, Job Mixed: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium pyrophosphate (TSPP), 1/2 cup (125 mL) of laundry detergent, and 20 quarts (20 L) of hot water for every 5 gal. (20 L) of solution required.
- D. Nonacidic Liquid Chemical Cleaner: Manufacturer's standard mildly alkaline liquid cleaner, formulated for removing organic soiling from ordinary building materials including polished stone, brick, copper, brass, bronze, aluminum, stainless steel, plastics, wood, and glass.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Building Restoration Products, Inc.
 - b. Cathedral Stone Products, Inc.
 - c. Dumond Chemicals, Inc.
 - d. PROSOCO, Inc.
- E. Abrasive Materials:
 - 1. Abrasive Pads for Copper-Alloy Cleaning: Extra fine bronze wool or plastic abrasive pads.
 - 2. Blasting Abrasive: [Pulverized walnut shells] [Powdered aluminum silicate] .
 - 3. Abrasives for Ferrous Metal Cleaning: Aluminum oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes of various sizes.
- F. Rust Remover: Manufacturer's standard phosphoric acid-based gel formulation, also called "naval jelly," for removing corrosion from iron and steel.

3.02 PAINT REMOVERS

- A. Alkaline Paste Paint Remover: Manufacturer's standard alkaline paste or gel formulation for removing paint from metals, and containing no methylene chloride.
 - 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 Building Restoration Products, Inc.
 - b. Diedrich Technologies, Inc.; a Hohmann & Barnard company.
 - c. EaCo Chem, Inc.
- B. Covered or Skin-Forming Alkaline Paint Remover: Manufacturer's standard covered or skin-forming alkaline paste or gel formulation for removing paint from metal, and containing no methylene chloride.
 - 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 Building Restoration Products, Inc.
 - b. Dumond Chemicals, Inc.
- C. Solvent-Type Paste Paint Remover: Manufacturer's standard water-rinsable, solvent-type paste or gel formulation for removing paint from metals.
 - 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. Diedrich Technologies, Inc.; a Hohmann & Barnard company.
 - b. PROSOCO, Inc.
 - c. Shore Corporation.
- D. Low-Odor, Solvent-Type Paste Paint Remover: Manufacturer's standard low-odor, water-rinsable, solvent-type paste, gel, or foamed emulsion formulation for removing paint from metals; and containing no methanol or methylene chloride.
 - 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 Building Restoration Products, Inc.

- b. Cathedral Stone Products, Inc.
 - c. Diedrich Technologies, Inc.; a Hohmann & Barnard company.
 - d. Dumond Chemicals, Inc.
 - e. EaCo Chem, Inc.
 - f. PPG Paints; PPG Industries, Inc.
 - g. PROSOCO, Inc.
- E. Covered, Solvent-Type Paste Paint Remover: Manufacturer's standard, low-odor, covered, water-rinsable, solvent-type paste or gel formulation for removing paint from metals; and containing no methanol or methylene chloride.
- 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. Dumond Chemicals, Inc.
 - b. PROSOCO, Inc.

3.03 MISCELLANEOUS MATERIALS

- A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline cleaners.
- 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 Building Restoration Products, Inc.
 - b. PROSOCO, Inc.
 - c. Price Research, Ltd. dba Charles Paint Research.
- B. Masking Tape: Nonstaining, nonabsorbent material; compatible with chemical solutions being used and substrate surfaces; and that will easily come off entirely, including adhesive.
- C. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
- 1. Previous effectiveness in performing the work involved.
 - 2. Little possibility of damaging exposed surfaces.
 - 3. Consistency of each application.
 - 4. Uniformity of the resulting overall appearance.
 - 5. Do not use products or tools that could do the following:
 - a. Remove, alter, or in any way harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in the Contract.
 - b. Leave an unintended residue on surfaces.

3.04 FERROUS METAL PRIMERS

- A. Repair Primer: Manufacturer's standard, rust-inhibiting, fast-curing, lead- and chromate-free, universal primer, compatible with [firmly adhered existing paint and] applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry-film thickness.
- B. Finish Primer: Primer complying with applicable requirements in [Section 090391 "Historic Treatment of Plain Painting"] for finish painting of primed historic metal.

PART 3 EXECUTION

4.01 HISTORIC TREATMENT SPECIALIST

- A. Historic Treatment Specialist Firms: Subject to compliance with requirements [provide historic decorative metal cleaning by one of the following] [firms that may provide historic decorative metal cleaning include, but are not limited to, the following]:
- 1. .

4.02 PROTECTION

- A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.
 - 1. Cover adjacent surfaces with materials that are proven to resist chemical solutions being used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
 - 2. Do not apply chemical solutions during winds of sufficient force to spread them to unprotected surfaces.
 - 3. Neutralize alkaline and acid wastes before disposal.
 - 4. Dispose of runoff from 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.

4.03 HISTORIC DECORATIVE METAL CLEANING, GENERAL

- A. Have historic decorative metal cleaning performed by a historic treatment specialist.
- B. Cleaning Appearance Standard: Cleaned surfaces are to have a uniform appearance as viewed from [20 (6)] [50 (15)] feet (m) away by Architect.
- C. Execution of the Work: In cleaning historic items, disturb them as minimally as possible and as follows:
 - 1. Remove deteriorated coatings and corrosion.
 - 2. Sequence work to minimize time before protective coatings are reapplied.
 - 3. Clean items in place unless otherwise indicated.
- D. Mechanical Coating Removal: Use most gentle mechanical methods, such as scraping and wire brushing, that will not abrade metal substrate. Do not use abrasive methods such as sanding or power tools except as indicated as part of the historic treatment program and approved by Architect.
- E. Repaint: Where indicated, prepare painted decorative metal by [cleaning surface, removing less than firmly adhered existing paint, sanding edges smooth,] [removing existing paint] and priming for painting as specified.

4.04 CLEANING

- A. Use only those methods indicated for each type of decorative metal and its location.
 - 1. Brushes: If using wire brushes, use brushes of same base metal composition as metal being treated. Use brushes that are resistant to chemicals being used.
 - 2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.
 - a. Equip units with pressure gages.
 - b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
 - c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
 - d. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
 - e. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F (60 and 71 deg C) at flow rates indicated.
 - 3. Uniformity: Perform each cleaning method in a manner that results in uniform coverage of all surfaces, including corners, contours, and interstices, and that produces an even effect

- without streaks or damaging surfaces.
4. Protection: After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.
- B. Water Cleaning: Clean with [cold] [hot] water applied by [low] [medium] [high]-pressure spray. Supplement with [natural-fiber] [or] [plastic] bristle brush. Use small brushes to remove soil from joints and crevices.
- C. Detergent Cleaning:
1. Wet surface with [cold] [hot] water applied by low-pressure spray.
 2. Scrub surface with detergent solution and [natural-fiber] [or] [plastic] bristle brush until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
 3. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove detergent solution and soil.
 4. Repeat cleaning procedure where needed if required to produce cleaning effect established by mockup.
- D. Nonacidic Liquid Chemical Cleaning: Apply chemical cleaner to surfaces according to chemical-cleaner manufacturer's written instructions.
1. Wet surface with [cold] [hot] water applied by low-pressure spray.
 2. Apply cleaner to surface [in two applications] by brush [or low-pressure spray].
 3. Let cleaner remain on surface for period [recommended in writing by chemical-cleaner manufacturer] [established by mockup] [of two to three minutes] .
 4. Non-Ferrous Metals: Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and soil.
 5. Ferrous Metals: Do not rinse ferrous metals with water; neutralize chemical cleaner on ferrous metals as recommended in writing by manufacturer. Dry immediately with clean soft cloths. Follow direction of grain in metal.
 6. Repeat cleaning procedure where needed if required to produce cleaning effect established by mockup. Do not repeat more than once.
- E. Cleaning with Abrasive Pads: Clean surfaces to remove dirt[, leaving uniform patina intact,] by light rubbing with abrasive pads and water. [Rinse with cold water to remove residue. Apply rinse by low-pressure spray] [Do not rinse ferrous metals with water; wipe with damp cloths to remove residue] .
- F. Cleaning by Abrasive Blasting: Clean surfaces to remove dirt[, leaving uniform patina intact,] by dry blasting with specified blasting abrasive at pressure and distance from surface indicated below. [Rinse with cold water, low-pressure spray to remove residue] [Do not rinse ferrous metals with water; wipe with damp cloths to remove residue] .
1. Pressure and Distance from Surface: Maximum pressure of [60 (415)] [100 (690)] [200 (1375)] psi (kPa) with specified blasting abrasive propelled from a distance of [6 to 12 (152 to 305)] [12 to 18 (305 to 457)] inches (mm) from the surface.
 2. Pressure and Distance from Surface: As established by mockup.
- G. Chemical Rust Removal:
1. Remove loose rust scale with approved abrasives for ferrous metal cleaning.
 2. Apply rust remover with brushes or as recommended in writing by manufacturer.
 3. Allow rust remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing. Do not allow extended dwell time.
 4. Wipe off residue with mineral spirits and either steel wool or soft rags, or clean with method recommended in writing by manufacturer to remove residue.
 5. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
 6. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

H. Mechanical Rust Removal:

1. Remove rust with approved abrasives for ferrous metal cleaning.
2. Wipe off residue with mineral spirits and either steel wool or soft rags.
3. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
4. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

4.05 PAINT REMOVAL

A. Use only those paint-removal methods indicated for each type of decorative metal.

1. Application: Apply paint removers according to paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.
 - a. Apply materials to all surfaces, corners, contours, and interstices, to provide a uniform final appearance without streaks.
 - b. After work is complete, remove protection no longer required. Remove tape and adhesive marks.
2. Brushes: If using wire brushes, use brushes of same base metal composition as metal being treated. Use brushes that are resistant to chemicals being used.
3. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.
 - a. Equip units with pressure gages.
 - b. Unless otherwise indicated, hold spray nozzle at least 6 inches (152 mm) from surface and apply material in horizontal, back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
 - c. For chemical spray application, use low-pressure tank or chemical pump suitable for chemical indicated, equipped with cone-shaped spray.
 - d. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
 - e. For high-pressure water-spray application, use fan-shaped spray tip that disperses water at an angle of at least 40 degrees.
 - f. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F (60 and 71 deg C) at flow rates indicated.

B. Paint Removal with Alkaline Paste Paint Remover:

1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted metal with brushes.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
4. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and paint residue.
5. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
6. Repeat process if necessary to remove all paint.

C. Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:

1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted metal with brushes or as recommended in writing by manufacturer.
3. Apply cover according to manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and paint residue.

7. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
 8. For spots of remaining paint, apply alkaline paste paint remover according to "Paint Removal with Alkaline Paste Paint Remover" Paragraph.
- D. Paint Removal with Solvent-Type Paste Paint Remover:
1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
 2. Apply thick coating of paint remover to painted decorative metal with natural-fiber cleaning brush, deep-nap roller, or large paint brush. Apply in one or two coats according to manufacturer's written instructions.
 3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
 4. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and paint residue.
 5. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
 6. Repeat process if necessary to remove all paint.
- E. Paint Removal with Covered, Solvent-Type Paste Paint Remover:
1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
 2. Apply paint remover to dry, painted decorative metal with natural-fiber cleaning brush, deep-nap roller, or large paint brush; or as recommended in writing by manufacturer.
 3. Apply cover according to manufacturer's written instructions.
 4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
 5. Scrape off paint and remover.
 6. Rinse with [cold] [hot] water applied by [low] [medium] [high]-pressure spray to remove chemicals and paint residue.
 7. Use mechanical methods recommended in writing by manufacturer to remove remaining chemicals and paint residue.

4.06 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.
- B. Notify testing agency in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until inspectors have had reasonable opportunity to inspect work areas at locations of lift devices or scaffolding.
- C. Manufacturer's Field Service: Engage chemical-cleaner and paint-remover manufacturers' factory-authorized service representatives for consultation and Project-site inspection[, to perform preconstruction product testing,] and to provide on-site assistance when requested by Architect.

4.07 REMOVAL, DISMANTLING, AND REINSTALLATION

- A. Perform removal, dismantling, and reinstallation work as required in Section 024296 "Historic Removal and Dismantling" and Section 050372 "Historic Decorative Metal Repair."

4.08 PRIMING

- A. Repair Primer: Apply immediately after completing a repair.
- B. Finish Primer: Apply as soon after cleaning as possible.

4.09 HISTORIC DECORATIVE METAL CLEANING SCHEDULE

- A. Treatment of Decorative Railing [DMR-1] : Wrought-iron railing and gate.
 1. Perform work [in the shop] [or] [in the field].
 2. Paint Removal: [Alkaline paste paint remover] [Covered or skin-forming alkaline paint remover] [Solvent-type paste paint remover] [Low-odor, solvent-type paste

- paint remover] [Covered, solvent-type paint remover] .
- 3. Repairs: As specified in Section 050372 "Historic Decorative Metal Repair."
- 4. Painted Finish: As specified in [Section 090391 "Historic Treatment of Plain Painting."]
- B. Treatment of Decorative Railing [DMR-2] : Cast-iron balustrade.
 - 1. Perform work [in the shop] [or] [in the field].
 - 2. Paint Removal: [Alkaline paste paint remover] [Covered or skin-forming alkaline paint remover] [Solvent-type paste paint remover] [Low-odor, solvent-type paste paint remover] [Covered, solvent-type paste paint remover] .
 - 3. Rust Removal: [Chemical] [Mechanical] .
 - 4. Repair: As specified in Section 050372 "Historic Decorative Metal Repair."
 - 5. Painted Finish: As specified in [Section 090391 "Historic Treatment of Plain Painting."]
- C. Treatment of Decorative Railing [DMR-3] : Bronze railing with bronze handrail.
 - 1. Perform work [in the shop] [or] [in the field].
 - 2. Cleaning: [Water cleaning] [Detergent cleaning] [Chemical cleaning] [Abrasive blasting] .
 - 3. Repair: As specified in Section 050372 "Historic Decorative Metal Repair."
 - 4. Bronze Finish: [Satin finish with statuary conversion coating on railing; satin hand-rubbed finish, lacquered, on handrail] .
- D. Treatment of Decorative Cast-Iron Facade and Storefront [DMFS-#] : Repair facade and storefront and replace missing components.
 - 1. Perform work [in the shop] [or] [in the field].
 - 2. Cleaning: [Water cleaning] [Detergent cleaning] [Chemical cleaning] [Abrasive blasting] .
 - 3. Paint Removal: [Alkaline paste paint remover] [Covered or skin-forming alkaline paint remover] [Solvent-type paste paint remover] [Low-odor, solvent-type paste paint remover] [Covered, solvent-type paste paint remover] .
 - 4. Rust Removal: [Chemical] [Mechanical] .
 - 5. Repair: As specified in Section 050372 "Historic Decorative Metal Repair."
 - 6. Finish Treatment: As specified in [Section 050373 "Historic Decorative Metal Refinishing."] [Section 090391 "Historic Treatment of Plain Painting."]
- E. Treatment of Bronze Grille [DMG-#] : Strip paint and coat grille.
 - 1. Perform work [in the shop] [or] [in the field].
 - 2. Paint Removal: [Solvent-type paste paint remover] [Low-odor, solvent-type paste paint remover] [Covered, solvent-type paste paint remover] .
 - 3. Protective Coating: As specified in [Section 050373 "Historic Decorative Metal Refinishing."]

END OF SECTION 050371

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SECTION 050372
HISTORIC DECORATIVE METAL REPAIR

PART 1 GENERAL

2.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

2.02 SUMMARY

- A. Section Includes:
 - 1. Historic treatment of decorative metal in the form of repair as follows:
 - a. Repairing metals other than cast iron and replacing damaged and missing components in place.
 - b. Removing and dismantling metal for shop repair and replacement of components; reinstalling repaired metal.
 - c. Painting steel uncovered during the Work.
 - d. Installing wood rails supported by or attached to decorative metal railings or brackets.
- B. Related Requirements:
 - 1. Section 013591 "Historic Treatment Procedures" for general historic treatment requirements.

2.03 DEFINITIONS

- A. Low-Pressure Spray: [100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)] .
- B. Medium-Pressure Spray: [400 to 800 psi (2750 to 5510 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)] .
- C. High-Pressure Spray: [800 to 1200 psi (5510 to 8250 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)]

2.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] .
 - 1. Review minutes of Preliminary Historic Treatment Conference that pertain to historic treatment of decorative metal.
 - 2. Review methods and procedures related to historic decorative metal repair including, but not limited to, the following:
 - a. Historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.
 - c. Fire-protection plan.
 - d. Decorative metal historic treatment program.
 - e. Coordination with building occupants.

2.05 SEQUENCING AND SCHEDULING

- A. Perform decorative metal repair in the following sequence, which includes work specified in this and other Sections:
 - 1. Dismantle existing surface-mounted objects and hardware that overlie decorative metal surfaces except items indicated to remain in place. Tag items with location identification and protect.
 - 2. Verify that temporary protections have been installed.
 - 3. Examine condition of decorative metal.
 - 4. Clean decorative metal surface, and remove paint and other finishes to the extent required.
 - 5. Repair and replace existing decorative metal and supports to the degree required for a uniform and sound surface on which to paint or apply other finishes.

6. Cure repaired surfaces and allow them to dry for proper finishing.
7. Paint and apply other finishes.
8. Reinstall dismantled surface-mounted objects and hardware unless otherwise indicated.

2.06 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include recommendations for product application and use.
 2. Include test data substantiating that products comply with requirements.
- B. Shop Drawings:
 1. Include plans, elevations, and sections showing locations and extent of repair and replacement work, with enlarged details of replacement parts indicating materials, profiles, methods of attachment, accessory items, and finishes.
 2. Include field-verified dimensions and the following:
 - a. Full-size patterns with complete dimensions for new decorative metal components and their jointing, showing relation of existing to new components.
 - b. Templates and directions for installing anchor bolts and other anchorages.
 - c. Identification of each new metal item and component and its location on the structure in annotated plans and elevations.
 - d. Provisions for expansion, weep holes, and conduits as required for each location and exposure.
 - e. Provisions for sealant between decorative metal components and for sealant-type joints if required.
- C. Samples for Initial Selection: For each type of decorative metal item and component with factory-applied finishes.
 1. Include samples of sealant materials, miscellaneous materials, and accessories involving size, color, or finish selection.
- D. Samples for Verification: For the following products in manufacturer's standard sizes unless otherwise indicated, finished as required for use in the Work:
 1. Each type of new material to be used for replacing existing or missing decorative metal; 6 inches (150 mm) long in least dimension or whole item.
 - a. Patterns for Casting: Before casting components, submit the actual patterns from which molds will be made for casting. Package and ship to prevent loss or damage, or make patterns available for inspection by Architect at fabrication plant.
 - b. Casting Samples: For castings, provide one of each shape, color, and texture of component, suitable and ready for installation. [Make this submittal after acceptance of patterns for casting.]
 2. Fittings and brackets.
 3. Each type of exposed connection between components. Show method of finishing components at connections.
 4. Each type of exposed finish prepared on metal of the same alloy to be used for the Work of this Section; 6 inches (150 mm) long in least dimension.
 5. Wood Rail: 12 inches (300 mm) long.
 6. Sealant materials.
 7. Accessories: Each type of anchor, accessory, and miscellaneous support in required finishes.
- E. Delegated-Design Submittal: For structural performance of repaired [railings] [handrails] [handrail brackets] [and] [anchors] , including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

2.07 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For historic treatment specialist.
- B. Evaluation Reports: For post-installed structural anchors, from ICC-ES.
- C. Decorative Metal Historic Treatment Program: For repairing historic decorative metalwork.

2.08 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, including material, finish, source, and location on or in building.
 - 1. Cast Metal Replications: [Five] additional [castings of each type] [cast grilles of each type] .
 - 2. Wrought-Iron Decorative Railing Posts: [Five] additional posts[of each type] .
- B. Molds for Castings: On completion of manufacturing of cast components, deliver one unused mold of each shape and size of component to Project site. Deliver to a location and at a time determined by Owner, to become property of Owner.
 - 1. Deliver molds carefully packed, protected from dirt, moisture, and breakage so as to arrive in usable, undamaged condition and enable long-term storage and possible future use.

2.09 QUALITY ASSURANCE

- A. Historic Treatment Specialist Qualifications: A qualified historic decorative metal repair specialist.[Repair specialist shall be experienced in forge welding.] Experience[in torch- or arc-welding and] installing and finishing new decorative metal work is insufficient experience for decorative metal historic treatment work.
 - 1. Single Specialist: Have the work of [Section 050371 "Historic Decorative Metal Cleaning"] [Section 050372 "Historic Decorative Metal Repair"] [Section 050373 "Historic Decorative Metal Refinishing"] [Section 050374 "Historic Decorative Metal Replication"] [and] [Section 050383 "Historic Cast Iron Repair"] performed by the same historic treatment specialist firm, meeting the specialist qualifications of those Sections.
- B. Decorative Metal Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for historic decorative metal repair work, including each process or phase of repairing decorative metal, related work, and the protection of surrounding materials and Project site.
 - 1. If materials and methods other than those indicated are proposed for any phase of historic treatment work, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.
- C. Mockups: Prepare mockups of historic treatment repair processes[on existing surfaces] to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation. Prepare mockups so they are inconspicuous.
 - 1. Replacing Metal Component: [Two] each of [wrought-iron spirals replaced on gate] [and] [cast-bronze wall registers] .
 - 2. Cast-Metal Components: Submit patterns, models, or plaster castings made from existing decorative metal for each replacement casting required.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

2.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with historic treatment of decorative metal only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 PRODUCTS

3.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design [railings] [handrails] [handrail brackets] [and] [anchors] according to structural performance requirements.

- B. Structural Performance: [Railings] [handrails] [and] [handrail brackets] , including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Uniform load of 50 lbf/ft.(0.73 kN/m) applied in any direction.
 2. Concentrated load of 200 lbf(0.89 kN) applied in any direction.
 3. Uniform and concentrated loads need not be assumed to act concurrently.

3.02 METAL MATERIALS

- A. Provide metal materials made of the alloys, forms, and types that match existing metals and have the ability to receive finishes matching existing finishes unless otherwise indicated. Exposed-to-view surfaces exhibiting imperfections inconsistent with existing materials are unacceptable.
- B. Source Limitation for Replacement Cast Materials: Obtain castings for historic treatment of decorative metal from single source from single manufacturer with resources to provide materials of consistent quality in appearance and physical properties.
- C. Aluminum: Alloy and temper recommended in writing by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required:
1. Extruded Bars and Shapes: ASTM B221 (ASTM B221M), Alloy 6063-T6.
 2. Extruded Structural Pipe and Tubes: ASTM B429/B429M, Alloy 6063-T6.
 3. Drawn General-Purpose Seamless Tubes: ASTM B210 (ASTM B210M), Alloy 6063-T832.
 4. Plate and Sheet: ASTM B209 (ASTM B209M), Alloy 6061-T6.
 5. Die and Hand Forgings: ASTM B247 (ASTM B247M), Alloy 6061-T6.
 6. Castings: ASTM B26/B26M, Alloy A356-T6.
- D. Copper Alloys, Bronze:
1. Extruded Shapes: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze, 57 percent copper, 40 percent zinc, and 3 percent lead).
 2. Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper and 40 percent zinc).
 3. Seamless Pipe: ASTM B43, Alloy UNS No. C23000 (red brass, 85 percent copper and 15 percent zinc).
 4. Seamless Tubes: ASTM B135 (ASTM B135M), Alloy UNS No. C23000 (red brass, 85 percent copper and 15 percent zinc).
 5. Composition Bronze Castings: ASTM B62, Alloy UNS No. C83600 ("85-5-5-5" is the common trade name; 85 percent copper and 5 percent each of tin, lead, and zinc).
 6. Sand Castings: ASTM B584, Alloy UNS No. C86500 (No. 1 manganese bronze; 58 percent copper, 39 percent zinc, 1 percent manganese, and small amounts of other metals).
- E. Copper Alloys, Brass:
1. Extruded Shapes: ASTM B249/B249M, Alloy UNS No. C36000 (free-cutting brass, 60 percent copper, 36 percent zinc, and small amounts of other metals).
 2. Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper and 30 percent zinc).
 3. Seamless Tubes: ASTM B135 (ASTM B135M), Alloy UNS No. C26000 (cartridge brass, 70 percent copper and 30 percent zinc).
 4. Sand Castings: ASTM B584, Alloy UNS No. C85200 (high-copper yellow brass, 72 percent copper, 24 percent zinc, and small amounts of other metals).
- F. Monel (Nickel-Copper Alloy):
1. Plate, Sheet, and Strip: ASTM B127, Alloy UNS No. N04400.
 2. Rod, Bar, and Wire: ASTM B164, Alloy UNS No. N04400.
 3. Seamless Tubes: ASTM B165, Alloy UNS No. N04400.
 4. Forgings: ASTM B564, Alloy UNS No. N04400.
 5. Sand Castings: Monel alloy matching Alloy UNS No. N04400.

- G. Nickel Silver (Copper-Nickel-Zinc Alloy):
 - 1. Extruded Shapes: ASTM B151/B151M, Alloy [UNS No. C74500] [UNS No. C75200].
 - 2. Plate, Sheet, Strip, and Bar: ASTM B122/B122M, Alloy [UNS No. C74500] [UNS No. C75200].
- H. Stainless Steel:
 - 1. Tubing: ASTM A554, [Grade MT-304] [Grade MT-316].
 - 2. Pipe: ASTM A312/A312M, [Grade TP304] [Grade TP316].
 - 3. Castings: ASTM A743/A743M, [Grade CF8 or CF20] [Grade CF8M].
 - 4. Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, [Type 304] [Type 316].
 - 5. Flat Bar: ASTM A666, [Type 304] [Type 316].
 - 6. Bars and Shapes: ASTM A276, [Type 304] [Type 316].
- I. Steel:
 - 1. Tubing: Cold formed, ASTM A500/A500M.
 - 2. Steel Plate, Shapes, and Bars: ASTM A36/A36M.
 - 3. Steel Bars: Mild steel; ASTM A29/A29M, Grade 1010.
 - 4. Steel Sheet: ASTM A1008/A1008M, cold-rolled commercial steel sheet; matte finish; suitable for exposed applications.
- J. Cast Iron: Standard designated below for each type of casting:
 - 1. Gray-Iron Castings: ASTM A48/A48M, Class 30.
 - 2. Malleable-Iron Castings: ASTM A47/A47M, grade as recommended in writing by fabricator for type of use indicated.
- K. Wrought Iron: [Pure iron with not more than 0.035 percent carbon and containing fibrous slag (iron silicate)] [Pure iron with not more than 0.035 percent carbon and no slag (iron silicate)] [or] [mild steel; ASTM A29/A29M, Grade 1010]; hand worked or machine forged to the form indicated.

3.03 WOOD MATERIALS

- A. Wood Rails: Hardwood rails of species and profile indicated, with [transparent finish] , and prepared for securing to metal subrail or brackets as indicated on Drawings.
 - 1. Species and Finish: [Match design reference sample] [Match existing] [As indicated on Drawings] [Ash, natural finish] [Cherry, natural finish] [Walnut, natural finish] [White oak, light-stained finish] .
 - 2. Profile: [Match design reference sample] [Match existing] [As indicated on Drawings] [Square shape, 1-3/4 by 1-3/4 inches (45 by 45 mm), with edges eased to 1/4-inch (6-mm) radius] [Rectangular shape, 1-3/4 by 5 inches (45 by 127 mm), with edges eased to 1/4-inch (6-mm) radius] [Round shape, 2-inch (50-mm) diameter] .
- B. Wood Rails: Hardwood rails of species and profile [matching design reference sample] [matching existing] [as indicated on Drawings] , complying with [Section 050383 "Historic Cast Iron Repair."] [Section 060312 "Historic Wood Repair."] [Section 064013 "Exterior Architectural Woodwork."] [Section 064023 "Interior Architectural Woodwork."]

3.04 PREPARATORY CLEANING MATERIALS

- A. Water: Potable.
- B. Hot Water: Water heated to a temperature of 140 to 160 deg F (60 to 71 deg C).
- C. Detergent Solution, Job Mixed: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium pyrophosphate (TSPP), 1/2 cup (125 mL) of laundry detergent, and 20 quarts (20 L) of hot water for every 5 gal. (20 L) of solution required.
- D. Abrasive Materials:
 - 1. Abrasive Pads: Non-scratch, of the following type(s):

- a. Abrasive Pad with Sponge: Combination plastic abrasive pad, consisting of a sponge enclosed with a woven urethane, polypropylene, or other plastic mesh or fabric, without other abrasive components that can scratch metal.
- b. Abrasive Pad of Plant Fibers: Agave, loofa, or another tough plant fiber, without other abrasive components that can scratch metal.
2. Medium Abrasives for Ferrous Metals: Aluminum oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes of various sizes.
3. Medium Abrasives for Copper Alloys: Extra fine bronze wool or plastic abrasive pads.
4. Blasting Abrasive: [Pulverized walnut shells] [Powdered aluminum silicate] .
- E. Wash Cloths: Lint-free, absorbent, durable cloth without abrasives that can scratch metal.
- F. Rust Remover: Manufacturer's standard phosphoric acid-based gel formulation, also called "naval jelly," for removing corrosion from iron and steel.

3.05 FASTENERS

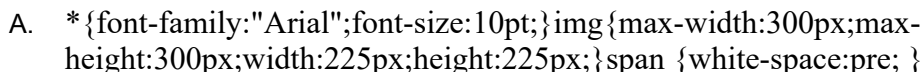
- A. Fasteners: Fasteners of the same basic metal as fastened metal unless otherwise indicated. Use metals that are noncorrosive and compatible with each metal joined.
 1. Match existing fasteners in material and in type of fastener unless otherwise indicated.
 2. Use concealed fasteners for interconnecting decorative metal components and for attaching them to other work unless exposed fasteners are [unavoidable] [or] [the existing fastening method].
 3. For exposed fasteners, use Phillips-type machine screws of head profile flush with metal surface unless otherwise indicated[or another head is required to match the existing fastening method as determined by Architect].
 4. Finish heads of exposed fasteners to match finish of metal fastened unless otherwise indicated.
- B. Post-Installed Structural Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES [AC01] [AC193] [AC58] [or] [AC308] as appropriate for the substrate.
 1. Uses: Securing [railings] [handrails] [and] [handrail brackets] to structure.
 2. Type: [Torque-controlled, expansion anchor] [torque-controlled, adhesive anchor] [or] [adhesive anchor].
 3. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941 (ASTM F1941M), Class Fe/Zn 5, unless otherwise indicated.
 4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [Group 1 (A1)] [Group 2 (A4)] stainless steel bolts, ASTM F593 (ASTM F738M), and nuts, ASTM F594 (ASTM F836M).
- C. Post-Installed Nonstructural Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES [AC01] [AC193] [AC58] [or] [AC308] as appropriate for the substrate.
 1. Type: [Expansion anchor] [adhesive anchor] [types matching existing] [or] [types indicated on Drawings].
 2. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941 (ASTM F1941M), Class Fe/Zn 5, unless otherwise indicated.
 3. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [Group 1 (A1)] [Group 2 (A4)] stainless steel bolts, ASTM F593 (ASTM F738M), and nuts, ASTM F594 (ASTM F836M).

3.06 ACCESSORIES

- A. Metal-Patching Compound: Two-part, epoxy- or polyester-resin, metal-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of metal repair indicated, tooling time required for the detail of work, and site conditions. Compound shall be produced for filling metal that has deteriorated because of corrosion or deformation. Filler shall be capable of filling deep holes and spreading to feather edge.

- B. Brazing Rods for Copper Alloys: Type and alloy as recommended in writing by brazing-rod manufacturer and as required for color match, strength, and compatibility in fabricated items.
- C. Welding Electrodes and Filler Metal: Select according to AWS specifications for metal alloy welded; use metal type and alloy as required for color match, strength, and compatibility in fabricated items.
- D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended in writing by manufacturer for interior and exterior applications.
- E. 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 in writing by manufacturer for exterior use.
- F. Sealant Materials:
 - 1. Provide manufacturer's standard, elastomeric [nonstaining, single-component, nonsag silicone] [single-component, nonsag urethane] sealant complying with applicable requirements in Section 079200 "Joint Sealants."
 - 2. Colors: Provide colors of exposed sealants to match colors of metals in which sealant is placed unless otherwise indicated.
- G. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer according to [MPI #23 (surface tolerant, anticorrosive metal primer)] [or] [SSPC-Paint 20 or SSPC-Paint 29] .
 - 1. Surface Preparation: Use coating requiring no better than [SSPC-SP 2, "Hand Tool Cleaning"] [SSPC-SP 3, "Power Tool Cleaning"] [or] [SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning"] surface preparation according to manufacturer's literature or certified statement.
 - 2. VOC Limit: Use coating with a VOC content of [400 g/L (3.3 lb/gal.)] or less.
- H. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- I. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline cleaners.
 - 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 Building Restoration Products, Inc.
 - b. PROSOCO, Inc.
 - c. Price Research, Ltd. dba Charles Paint Research.
- J. Masking Tape: Nonstaining, nonabsorbent material; compatible with chemical solutions being used and substrate surfaces, and that will easily come off entirely, including adhesive.
- K. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
 - 1. Previous effectiveness in performing the work involved.
 - 2. Little possibility of damaging exposed surfaces.
 - 3. Consistency of each application.
 - 4. Uniformity of the resulting overall appearance.
 - 5. Do not use products or tools that could do the following:
 - a. Remove, alter, or in any way harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in the Contract.
 - b. Leave an unintended residue on surfaces.

3.07 METAL FABRICATION

- A. 
1. Allen Architectural Metals, Inc.
 2. Alloy Casting Co., Inc.
 3. Antique Cast Iron, LLC.
 4. Architectural Iron Company, Inc.
 5. Historical Arts & Casting, Inc.
 6. Olek Lejbzon & Co.
 7. Postville Blacksmith Shop.
 8. Robinson Iron.
 9. Schiff Architectural Detail.
 10. Vintage Metalwork Inc.
 11. f2 Industries.
- B. Custom fabricate repairs of decorative metal items and components in sizes and profiles to match existing decorative metal unless otherwise indicated, with accurate curves, lines, and angles. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
- C. Provide uniform, neat seams with minimum exposure of welds, brazing, solder, and sealant.
- D. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for fasteners. Use concealed fasteners where possible; use exposed fasteners to match existing work.
- E. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.
1. Use materials and methods that match color of base metal, minimize distortion, and develop maximum strength and corrosion resistance.
 2. Remove flux immediately.
 3. At exposed connections, match contours of adjoining surfaces, and finish exposed surfaces smooth and blended so no roughness shows after finishing.
- F. Castings: Fabricate castings free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.
1. Finish castings to match existing decorative metal work.
 2. Replacement Casting for Handrail Bracket: Duplicate existing handrail bracket on the wrought-iron railing of first-floor stairs in the lobby. Make molds from this bracket to create new cast-bronze brackets.
- G. Date Identification: Emboss on a concealed, interior surface of the metal body of each new component, in easily read characters, "MADE ." Manufacturer's name may also be embossed.[For cast metals, add the identification to the mold pattern before casting.][For malleable metals, stamp identification with an imprinting tool.]

3.08 FINISHES, GENERAL

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- 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.

3.09 ALUMINUM FINISHES

- A. Mill finish.

- B. Clear Anodic Finish: AAMA 611, [Class I, 0.018 mm] [Class II, 0.010 mm] or thicker over a [satin (directionally textured)] [polished (buffed)] [nonspecular as fabricated] mechanical finish.
- C. Color Anodic Finish: AAMA 611, [Class I, 0.018 mm] [Class II, 0.010 mm] or thicker over a [satin (directionally textured)] [polished (buffed)] [nonspecular as fabricated] mechanical finish.
- D. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

3.10 COPPER-ALLOY FINISHES

- A. Finish designations for copper alloys comply with the system defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)."
- B. Buffed Finish: [M21 (Mechanical Finish: buffed, smooth specular)] [M22 (buffed, specular mechanical finish)] .
- C. Buffed Finish, Lacquered: [M22 (Mechanical Finish: buffed, specular; specified clear organic coating)] .
- D. Satin Hand-Rubbed Finish: [M32-M34 (Mechanical Finish: directionally textured, medium satin and hand-rubbed)] .
- E. Satin Hand-Rubbed Finish, Lacquered: [M32-M34-06x (Mechanical Finish: directionally textured, medium satin and hand-rubbed; specified clear organic coating)] .
- F. Satin Finish with Statuary Conversion Coating: [M32-C55 (directionally textured, medium satin; sulfide conversion coating)] .
 - 1. Color: [Match design reference sample] [Match existing] [Match Architect's sample] .
- G. Brushed Finish with Patina Conversion Coating: M35-C12-C52 (directionally textured, rotary brushed and buff polished, nonetched cleaned; ammonium sulfate conversion coating).
 - 1. Texture and Color: [Match design reference sample] [Match existing] [Match Architect's sample] .
- H. Bright-Relieved Statuary Conversion Coating, Lacquered: M12-C55-M2x-06x (matte finish as cast; sulfide conversion coating; buffed to brighten high spots; specified clear organic coating):
 - 1. Color and Buffing: [Match design reference sample] [Match existing] [Match Architect's sample] .
- I. Patina Finish: .

3.11 FERROUS METAL FINISHES

- A. Repair Primer: Manufacturer's standard, rust-inhibiting, fast-curing, lead- and chromate-free universal primer, compatible with [firmly adhered existing paint and] applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
- B. Finish Primer: Primer complying with applicable requirements in [Section 090391 "Historic Treatment of Plain Painting"] for finish painting of primed metal.
- C. 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.
- D. Patina Finish: .

3.12 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines from new replacement stainless steel, or blend into finish.
- B. Restored Finish: Grind and polish surfaces to produce uniform, directionally textured, polished finish to match [existing finish] [Architect's sample], free of cross scratches.
 - 1. Run grain to match existing metal.
 - 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- C. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. Run grain of directional finishes with long dimension of each piece.
 - 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - 3. Directional Satin Finish: ASTM A480/A480M, No. 4.
 - 4. Dull Satin Finish: ASTM A480/A480M, No. 6.
 - 5. Reflective, Directional Polish: ASTM A480/A480M, No. 7.
 - 6. Mirrorlike Reflective, Nondirectional Polish: ASTM A480/A480M, No. 8.
- D. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M, No. 2B.

PART 3 EXECUTION

4.01 HISTORIC TREATMENT SPECIALIST

- A. Historic Treatment Specialist Firms: Subject to compliance with requirements [provide historic decorative metal repair by one of the following] [firms that may provide historic decorative metal repair include, but are not limited to, the following]:
 - 1. .

4.02 PROTECTION

- A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.
 - 1. Cover adjacent surfaces with materials that are proved to resist chemical solutions being used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
 - 2. Do not apply chemical solutions during winds of enough force to spread them to unprotected surfaces.
 - 3. Neutralize alkaline and acid wastes before disposal.
 - 4. Dispose of runoff from 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.

4.03 HISTORIC DECORATIVE METAL REPAIR, GENERAL

- A. Repair Appearance Standard: Repaired surfaces are to have a uniform appearance as viewed from [20 feet (6 m)] [50 feet (15 m)] away by Architect.
- B. Execution of the Work: In repairing historic items, disturb remaining existing work as minimally as possible and as follows:
 - 1. Stabilize decorative metal to reestablish structural integrity and weather resistance while maintaining the existing form of each item.
 - 2. Remove deteriorated coatings and corrosion.
 - 3. Sequence work to minimize time before protective coatings are reapplied.
 - 4. Repair items where stabilization is insufficient to stop progress of deterioration.

5. Repair items in place unless otherwise indicated and retain as much original material as possible.
 6. Replace or reproduce historic items where indicated or scheduled.
 7. Make historic treatment of materials reversible whenever possible.
 8. Install temporary protective measures to stabilize decorative metal that is indicated to be repaired later.
- C. Mechanical Coating Removal: Use gentlest mechanical methods, such as scraping and wire brushing, that do not abrade metal substrate. Do not use abrasive methods, such as sanding, or power tools except as indicated as part of the historic treatment program and approved by Architect.
- D. Repairing Decorative Metal Items: Match existing materials and features, retaining as much original material as possible to complete the repair.
1. Unless otherwise indicated, repair decorative metals by patching, filling, piecing-in, splicing, or otherwise reinforcing metals with new material matching existing.
 2. Where indicated, repair decorative metal by limited replacement to the extent indicated, matching existing material.
- E. Replacing Decorative Metal Components: Where indicated, duplicate and replace items with new metal matching existing metal.
1. Replace heavily deteriorated or missing parts or features of decorative metal with compatible materials, using surviving prototypes to create patterns or molds for duplicate replacements.
 2. Do not use substitute materials unless otherwise indicated.
 3. Compatible substitute materials may be used.

4.04 PREPARATORY CLEANING

- A. Perform preparatory cleaning before performing repair work. Use only those methods indicated for each type of decorative metal and its location.
1. Brushes: If using wire brushes, use brushes of same base metal composition as metal being treated. Use brushes that are resistant to chemicals being used.
 2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.
 - a. Equip units with pressure gages.
 - b. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
 - c. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
 - d. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F (60 and 71 deg C) at flow rates indicated.
 3. Uniformity: Perform each cleaning method in a manner that results in uniform coverage of all surfaces, including corners, contours, and interstices, and that produces an even effect without streaks or damaging surfaces.
 4. Protection: After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.
- B. Water Cleaning: Clean with [cold] [hot] water applied with [sponges or wash cloths] [low-pressure spray] [medium-pressure spray] [high-pressure spray]. Supplement with [natural-fiber] [or] [plastic] bristle brush[and abrasive pads]. Use small brushes to remove soil and loose paint from joints and crevices.[Leave uniform patina intact.]
- C. Detergent Cleaning:
1. Wet surface with [cold] [hot] water applied with [sponges or wash cloths] [low-pressure spray].
 2. Scrub surface with detergent solution and [natural-fiber] [or] [plastic] bristle brush[and abrasive pads] until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.[Leave uniform patina

- intact.]
3. Rinse with [cold] [hot] water applied with [sponges or wash cloths] [low-pressure spray] [medium-pressure spray] [high-pressure spray] to remove detergent solution and soil.
- D. Cleaning by Abrasive Blasting: Clean surfaces to remove dirt[and loose paint] by dry blasting with specified blasting abrasive at pressure and distance from surface indicated below. [Rinse with cold-water, low-pressure spray to remove residue.] [Do not rinse ferrous metals with water; wipe with soft brushes and damp cloths to remove residue.] .[Leave uniform patina intact.]
1. Pressure and Distance from Surface: Maximum pressure of [60 psi (415 kPa)] [100 psi (690 kPa)] [200 psi (1375 kPa)] with specified blasting abrasive propelled from a distance of [6 to 12 inches (152 to 305 mm)] [12 to 18 inches (305 to 457 mm)] from surface.
 2. Pressure and Distance from Surface: As established by mockup.
- E. Chemical Rust Removal:
1. Remove loose rust scale with approved, medium abrasives for ferrous metals.
 2. Apply rust remover with brushes or as recommended in writing by manufacturer.
 3. Allow rust remover to remain on surface for period recommended in writing by manufacturer or as determined by testing. Do not allow extended dwell time.
 4. Wipe off residue with mineral spirits and either steel wool or soft rags, or clean with method recommended in writing by manufacturer to remove residue.
 5. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
 6. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.
- F. Mechanical Rust Removal:
1. Remove rust with approved, medium abrasives for ferrous metals.
 2. Wipe off residue with mineral spirits and either steel wool or soft rags.
 3. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
 4. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

4.05 DISMANTLING, REPAIR, AND INSTALLATION

- A. Repair decorative metal in place insofar as practicable, unless otherwise indicated. Where necessary, dismantle components from their substrate and repair and reinstall according to approved historic treatment program.
- B. Perform dismantling work as required in Section 024296 "Historic Removal and Dismantling."
- C. Installation:
1. Locate and place decorative metal iron items level and plumb and in alignment with adjacent construction.
 - a. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.
 2. Use concealed anchorages where possible, unless otherwise indicated.
 3. Form tight joints with exposed connections accurately fitted together.
 4. Install concealed joint fillers, sealants, and flashings, as the Work progresses, to make exterior items weatherproof.
 5. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.
 6. Touch Up: At completion of installation, touch up and restore damaged or defaced finish surfaces and fastener heads.
- D. Reinstalling [Railing] [and] [Fence] 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. Leave anchorage joint exposed, wipe off surplus anchoring material, and leave 1/8-inch (3-mm) buildup sloped away from post.

- E. Anchoring Wood Rails: Secure wood rails to metal subrail or brackets from bottom of rail as indicated on Drawings. Make fastener heads flush to metal surface of subrail or brackets.
- F. Sealant: Clean and prepare joint surfaces and apply and cure sealant according to Section 079200 "Joint Sealants."
 - 1. Keep joints to receive sealant dry and free of debris.
 - 2. [Prime joint surfaces unless sealant manufacturer recommends against priming.] Do not allow primer to spill or migrate onto adjoining surfaces.
 - 3. Apply sealant on joint surfaces between abutting cast-metal components in a continuous application immediately before joining the components together. Remove excess after components are joined and tightened.
 - 4. Fill sealant-type joints with specified joint sealant as recommended in writing by sealant manufacturer and the following:
 - a. Install sealant using only proved installation methods that ensure sealant is deposited in a uniform, continuous ribbon, without gaps or air pockets, and with complete wetting of the joint bond surfaces equally on both sides. Fill joint flush with surrounding metal.
 - b. Do not allow sealant to overflow or spill onto adjoining surfaces or to migrate into the voids of adjoining surfaces, particularly rough or sculptural textures. Promptly remove excess and spillage of sealant as the work progresses. Clean adjoining surfaces by means necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes, as demonstrated in an approved mockup.

4.06 FILLING DEFECTS IN PAINTED SURFACES

- A. Repair non-load-bearing defects in existing metal surfaces, including dents and gouges more than [1/16 inch (1.6 mm)] [1/8 inch (3 mm)] deep or [1/2 inch (13 mm)] [1 inch (25 mm)] across and all holes and tears by filling with metal-patching compound. Remove burrs. Prime iron and steel surfaces immediately after repair to prevent flash rusting.
 - 1. Apply metal-patching compound to fill depressions, nicks, cuts, and other voids created by rusted, removed, or missing metal.
 - 2. Mix only as much patching compound as can be applied according to manufacturer's written instructions.
 - 3. Apply patching compound in layers of maximum 1/8 inch (3 mm) thickness and as recommended in writing by manufacturer until the void is completely filled.
 - 4. Finish patch surface smooth and shaped flush with adjacent contours, without voids in patch material.
 - 5. Clean spilled compound from adjacent materials immediately.

4.07 PRIMING

- A. Repair Primer: Apply immediately after completing a repair.
- B. Finish Primer: Apply as soon after cleaning as possible.

4.08 PAINTING STEEL UNCOVERED DURING THE WORK

- A. Notify Architect if steel is exposed during metal removal. Where Architect determines that the steel is structural, or for other reasons cannot be totally removed, prepare and paint it as follows:
 - 1. Surface Preparation: Remove paint, rust, and other contaminants according to [SSPC-SP 2, "Hand Tool Cleaning,"] [SSPC-SP 3, "Power Tool Cleaning,"] [or] [SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning,"] as applicable to comply with paint manufacturer's recommended preparation.
 - 2. Antirust Coating: Immediately paint exposed steel with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's

recommended rate of application (dry film thickness per coat).

- B. If on inspection and rust removal the thickness of a steel member is found to be reduced from rust by more than [1/16 inch (1.6 mm)] , notify Architect before proceeding.

4.09 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.
- B. Notify testing agency in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until inspectors have had reasonable opportunity to inspect work areas at locations of lift devices or scaffolding.

4.10 HISTORIC DECORATIVE METAL REPAIR SCHEDULE

- A. Treatment of Decorative Railing [DMR-1] : Wrought-iron railing and gate.
 - 1. Perform work [in the shop] [or] [in the field].
 - 2. Paint Removal: As specified in Section 050371 "Historic Decorative Metal Cleaning."
 - 3. Repairs: Repair railing and replace missing components with hand-worked [steel bars] [wrought iron].
 - 4. Painted Finish: As specified in [Section 090391 "Historic Treatment of Plain Painting."]
 - 5. Baked-Enamel or Powder-Coat Finish: [Color as indicated by manufacturer's designations] [Color matching design reference sample] [Color matching Architect's sample] [Color as selected by Architect from manufacturer's full range]
 - 6. Gilding: As specified in [Section 090398 "Historic Treatment of Gilding."]
- B. Treatment of Decorative Railing [DMR-2] : Bronze railing with bronze handrail.
 - 1. Perform work [in the shop] [or] [in the field].
 - 2. Cleaning: As specified in Section 050371 "Historic Decorative Metal Cleaning."
 - 3. Repair: [Splice new material into deteriorated section] .
 - 4. Bronze Finish: [Satin finish with statuary conversion coating on railing; satin hand-rubbed finish, lacquered, on handrail] .
- C. Treatment of Decorative Railing and Handrail [DMRH-1] : Deteriorated [bronze] [wood] handrail on wrought-iron railing.
 - 1. Repair: Replace broken wrought-iron railing components and repaint railing. Replace entire, deteriorated [bronze] [wood] handrail with shop-fabricated [aluminum] [steel] [wood] handrail. Replicate wrought-iron as specified in Section 050374 "Historic Decorative Metal Replication."
 - 2. Paint Removal: As specified in Section 050371 "Historic Decorative Metal Cleaning."
 - 3. Railing Finish: Paint as specified in [Section 090391 "Historic Treatment of Plain Painting."]
 - a. Color: [As indicated by manufacturer's designations] [Matching design reference sample] [Matching Architect's sample] [As selected by Architect from manufacturer's full range] .
 - 4. Gilding: As specified in [Section 090398 "Historic Treatment of Gilding."]
 - 5. Handrail Finish:
 - a. Aluminum Finish: [Light bronze anodized] [Medium bronze anodized] [Dark bronze anodized] [Anodized color matching design reference sample] [Anodized color matching Architect's sample] [Anodized color as selected by Architect from full range of industry colors and color densities] .

- b. Baked-Enamel or Powder-Coat Finish: [Color as indicated by manufacturer's designations] [Color matching design reference sample] [Color matching Architect's sample] [Color as selected by Architect from manufacturer's full range] .

END OF SECTION 050372

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SECTION 050374
HISTORIC DECORATIVE METAL REPLICATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Replication and installation of historic decorative metal items and whole assemblies.
- B. Related Requirements:
 - 1. Section 013591 "Historic Treatment Procedures" for general historic treatment requirements.
 - 2. Section 050372 "Historic Decorative Metal Repair" for repairing historic decorative metalwork, including replicating components that are part of repair work.
 - 3. Section 057000 "Decorative Metal" for new decorative metal construction.
 - 4. Section 057300 "Decorative Metal Railings" for new decorative handrails and railings.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include plans, elevations, and sections showing locations and extent of replication work, with enlarged details of replacement parts indicating materials, profiles, methods of attachment, accessory items, and finishes.
 - 2. Include field-verified dimensions and the following:
 - a. Full-size patterns with complete dimensions for new decorative metal items and their jointing, showing relationship of existing items to new items.
 - b. Templates and directions for installing anchor bolts and other anchorages.
 - c. Identification of each new metal item and component and its location on the structure in annotated plans and elevations.
 - d. Provisions for expansion, weep holes, and conduits as required for each location and exposure.
 - e. Provisions for sealant joints if required.
- C. Samples for Initial Selection: For the following:
 - 1. Each type of decorative metal item and component with applied finishes.
 - 2. Sealant materials.
 - 3. Accessories to verify color selection.
- D. Samples for Verification: Actual sample of finished products for the following products in manufacturer's standard sizes unless otherwise indicated:
 - 1. Each type of new material to be used for replacing existing or missing decorative metal; 6 inches long in least dimension or whole item.
 - a. Patterns for Casting: Before casting items, submit the actual patterns from which molds will be made for casting. Package and ship to prevent loss or damage, or make patterns available for inspection by Architect at fabrication plant.
 - b. Casting Samples: For castings, provide one of each shape, color, and texture of component, suitable and ready for installation. Make this submittal after acceptance of patterns for casting.
 - 2. Fittings and brackets.
 - 3. Medallions.
 - 4. Each type of exposed connection between components. Show method of finishing components at connections.
 - 5. Each type of exposed finish prepared on metal of the same alloy to be used for the Work of this Section; 6 inches long in least dimension.
 - 6. Wood Rail: 12 inches long.
 - 7. Sealant materials.
 - 8. Accessories: Each type of anchor, accessory, and miscellaneous support in required finishes.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Statements: For historic treatment specialist.
- B. Decorative Metal Historic Treatment Program: For replicating historic decorative metal items and whole assemblies.

1.04 QUALITY ASSURANCE

- A. Historic Treatment Specialist Qualifications: A qualified historic decorative metal fabrication and installation specialist. Repair specialist to be experienced in forge welding. Experience installing and finishing new decorative metalwork is insufficient experience for historic decorative metal replication work.

1.05 MOCKUPS

- A. Prepare mockups of historic decorative metal replication and installation processes to demonstrate aesthetic effects, to set quality standards for materials and execution, and to set quality standards for fabrication and installation. Prepare mockups so they are inconspicuous.
 - 1. Replicated Wrought Iron Railing with Wood Handrail: Approximately 4 ft. in length.
 - 2. Cast-Metal Items: Submit patterns, models, or plaster castings made from existing decorative metal for each replacement casting required.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Pack, deliver, and store decorative metal items in suitable packs, heavy-duty cartons, or wooden crates; surround with sufficient packing material to ensure that products are not deformed, cracked, or otherwise damaged.
- B. Store decorative metal inside a well-ventilated area, away from uncured concrete and masonry and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.
- C. Protect strippable protective covering on decorative metal from exposure to sunlight and high humidity, except to extent necessary for period of decorative metal installation.

1.07 FIELD CONDITIONS

- A. Weather Limitations: Proceed with replication and installation of historic decorative metal items and whole assemblies only when existing and forecasted weather conditions are within environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 PRODUCTS

2.01 METAL MATERIALS

- A. General: Provide decorative metal materials made of alloys, forms, and types that match existing metals and have the ability to receive finishes matching existing finishes unless otherwise indicated. Exposed-to-view surfaces exhibiting imperfections inconsistent with existing materials are unacceptable.
- B. Source Limitation for Replacement Cast Materials: Obtain castings for replication of decorative metal items and whole assemblies from single source from single manufacturer with resources to provide materials of consistent quality in appearance and physical properties.
- C. Aluminum: Alloy and temper recommended in writing by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required:
 - 1. Extruded Bars and Shapes: ASTM B221, Alloy 6063-T6.
 - 2. Extruded Structural Pipe and Tubes: Alloy 6063-T6.
 - 3. Drawn General-Purpose Seamless Tubes: ASTM B483/B483M, Alloy 6063-T832.
 - 4. Plate and Sheet: ASTM B209, Alloy 6061-T6.
 - 5. Die and Hand Forgings: ASTM B247, Alloy 6061-T6.

6. Castings: ASTM B26/B26M, Alloy A356-T6.
- D. Cast Iron: Standard designated below for each type of casting:
 1. Gray-Iron Castings: ASTM A48/A48M, Class 30.
 2. Malleable-Iron Castings: ASTM A47/A47M, grade as recommended in writing by fabricator for type of use indicated.
- E. Wrought Iron: mild steel; ASTM A29/A29M, Grade 1010; hand worked or machine forged to the form indicated.

2.02 MISCELLANEOUS MATERIALS

- A. Wood Rails:
 1. Hardwood rails of species and profile indicated, with transparent finish, and prepared for securing to metal subrail or brackets as indicated on Drawings.
 - a. Species and Finish: As indicated on Drawings.
 - b. Profile: As indicated on Drawings.
- B. Welding Electrodes and Filler Metal: Select in accordance with AWS specifications for metal alloy welded; use metal type and alloy as recommended in writing by producer of metal to be welded or filled and as required for color match, strength, and compatibility in fabricated items.
- C. Brazing Rods for Cast-Iron Components: Type and alloy as recommended in writing by brazing-rod manufacturer and as required for strength and compatibility in fabricated items.
- D. Fasteners of same basic metal as fastened metal unless otherwise indicated. Use metals that are noncorrosive and compatible with each metal joined.
 1. Match existing fasteners in material and in type of fastener unless otherwise indicated.
 2. Use concealed fasteners for interconnecting decorative metal components and for attaching them to other work unless exposed fasteners are the existing fastening method.
 3. For exposed fasteners, use Phillips-type machine screws of head profile flush with metal surface unless otherwise indicated.
 4. Finish exposed fasteners to match finish of metal fastened unless otherwise indicated.
- E. Anchors: expansion type or types indicated on Drawings with bolt heads of same basic metal as fastened metal unless otherwise indicated. Use metals that are noncorrosive and compatible with each metal anchored.
 1. Strength: Capable of sustaining, 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 in accordance with ASTM E488/E488M conducted by a qualified independent testing agency.
- F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended in writing by manufacturer for interior and exterior applications.
- G. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
 1. Previous effectiveness in performing the work involved.
 2. Little possibility of damaging exposed surfaces.
 3. Consistency of each application.
 4. Uniformity of the resulting overall appearance.
 5. Do not use products or tools that could do the following:
 - a. Remove, alter, or in any way harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in the Contract.
 - b. Leave an unintended residue on surfaces.

2.03 METAL FABRICATION

- A. Fabricate decorative metal items and components in sizes and profiles to match existing historic decorative metal, with accurate curves, lines, and angles. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
- B. Provide uniform, neat seams with minimum exposure of welds, brazing, solder, and sealant.

- C. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for fasteners. Use concealed fasteners where possible; use exposed fasteners to match existing work.
- D. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.
 - 1. Use materials and methods that match color of base metal, minimize distortion, and develop maximum strength and corrosion resistance.
 - 2. Remove flux immediately.
 - 3. At exposed connections, match contours of adjoining surfaces, and finish exposed surfaces smooth and blended so no roughness shows after finishing.
- E. Fabricate castings free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.
 - 1. Finish castings to match existing decorative metalwork.

2.04 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. 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.

2.05 FERROUS METAL FINISHES

- A. Primer: Complying with applicable requirements in 90 91 23 "Interior Painting" for finish painting of primed decorative metal.

PART 3 EXECUTION

3.01 HISTORIC DECORATIVE METAL REPLICATION, GENERAL

- A. Execution of the Work: In replicating historic items, disturb remaining existing work as minimally as possible and as follows:
 - 1. Sequence work to minimize time before protective coatings are applied.
 - 2. Replace or reproduce historic items where indicated or scheduled.
 - 3. Make installation of replicated items reversible whenever possible.
- B. Replicate Decorative Metal Item: Where indicated, duplicate existing items with new materials matching existing materials and features.
 - 1. Design heavily deteriorated or missing features of historic decorative metal with compatible materials, using surviving prototypes to create patterns or molds for duplicating.
 - 2. Do not use substitute materials unless otherwise indicated.
 - 3. Compatible substitute materials may be used.

3.02 INSTALLATION

- A. Installing Railing Posts: After posts have been inserted in sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions. Leave anchorage joint exposed, wipe off surplus anchoring material, and leave 1/8-inch buildup sloped away from post.
- B. Anchoring Wood Rails: Secure wood rails to metal subrail or brackets from bottom of wood rail as indicated on Drawings. Make fastener heads flush to metal surface.

END OF SECTION 050374

**SECTION 050383
HISTORIC CAST IRON REPAIR**

PART 1 GENERAL

2.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

2.02 SUMMARY

- A. Section includes historic treatment of cast iron in the form of repair as follows:
 - 1. Repairing cast iron and replacing damaged and missing components in place.
 - 2. Removing and dismantling cast iron for shop repair and replacement of components; reinstalling repaired cast iron.
 - 3. Painting steel uncovered during the Work.
 - 4. Reanchoring cast iron to building structure.
 - 5. Installing [wood rails] [or] [rails of other metals] supported by or attached to cast-iron railings or brackets.
- B. Related Requirements:
 - 1. Section 013591 "Historic Treatment Procedures" for general historic treatment requirements.

2.03 DEFINITIONS

- A. Low-Pressure Spray: [100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)] .
- B. Medium-Pressure Spray: [400 to 800 psi (2750 to 5510 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)] .
- C. High-Pressure Spray: [800 to 1200 psi (5510 to 8250 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)]

2.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] .
 - 1. Review minutes of Preliminary Historic Treatment Conference that pertain to historic treatment of decorative metal.
 - 2. Review methods and procedures related to historic cast-iron repair including, but not limited to, the following:
 - a. Historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.
 - c. Fire-protection plan.
 - d. Cast-iron historic treatment program.
 - e. Coordination with building occupants.

2.05 SEQUENCING AND SCHEDULING

- A. Perform cast-iron repair in the following sequence, which includes work specified in this and other Sections:
 - 1. Dismantle existing surface-mounted objects and hardware that overlie cast-iron surfaces except items indicated to remain in place. Tag items with location identification and protect.
 - 2. Verify that temporary protections have been installed.
 - 3. Examine condition of cast iron.
 - 4. Clean cast-iron surface, and remove paint and other finishes to the extent required.
 - 5. Repair and replace existing cast iron and supports to the degree required for a uniform and sound surface on which to paint or apply other finishes.
 - 6. Cure repaired surfaces and allow them to dry for proper finishing.

7. Paint and apply other finishes.
8. Reinstall dismantled surface-mounted objects and hardware unless otherwise indicated.

2.06 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include recommendations for product application and use.
 2. Include test data substantiating that products comply with requirements.
- B. Shop Drawings:
 1. Include plans, elevations, and sections showing locations and extent of repair and replacement work, with enlarged details of replacement parts indicating materials, profiles, methods of attachment, accessory items, and finishes.
 2. Include field-verified dimensions and the following:
 - a. Full-size patterns with complete dimensions for new cast-iron components and their jointing, showing relation of existing to new components.
 - b. Templates and directions for installing anchor bolts and other anchorages.
 - c. Identification of each new cast-iron item and component and its location on the structure in annotated plans and elevations.
 - d. Provisions for expansion, weep holes, and conduits as required for each location and exposure.
 - e. Provisions for sealant between cast-iron components and for sealant-type joints if required.
 - f. Layout of metal stitching, including stitching-pin size(s) and lock length(s), spacing, and number of layers.
- C. Samples for Initial Selection: For each type of cast-iron item and component with factory-applied finishes.
 1. Include Samples of sealant materials, miscellaneous materials, and accessories involving size, color, or finish selection.
- D. Samples for Verification: For the following products in manufacturer's standard sizes unless otherwise indicated, finished as required for use in the Work:
 1. Each type of new material to be used for replacing existing or missing cast iron; 6 inches (150 mm) long in least dimension or whole item.
 - a. Patterns for Casting: Before casting components, submit the actual patterns from which molds will be made for casting. Package and ship to prevent loss or damage, or make patterns available for inspection by Architect at fabrication plant.
 - b. Casting Samples: For castings, provide one of each shape, color, and texture of component, suitable and ready for installation.[Make this submittal after acceptance of patterns for casting.]
 2. Fittings and brackets.
 3. Each type of exposed connection between components. Show method of finishing components at connections.
 4. Each type of exposed finish; 6 inches (150 mm) long in least dimension.
 5. Wood Rail: 12 inches (300 mm) long.
 6. Sealant materials.
 7. Accessories: Each type of anchor, accessory, and miscellaneous support in required finishes.
- E. Delegated-Design Submittal: For structural performance of repaired [railings] [handrail brackets] [and] [anchors] , including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

2.07 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For historic treatment specialist [historic brazing-and-welding specialist] [and] [historic metal-stitching specialist].
- B. Evaluation Reports: For post-installed structural anchors, from ICC-ES.
- C. Cast-Iron Historic Treatment Program: For repairing historic cast iron.

2.08 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, including material, finish, source, and location on or in building.
 - 1. Cast-Metal Replications: [Five] additional [castings of each type] [cast grilles of each type] .
 - 2. Cast-Iron Decorative Railing Posts: [Five] additional posts [of each type] .
- B. Molds for Castings: On completion of manufacturing of cast components, deliver one unused mold of each shape and size of component to Project site. Deliver to a location and at a time determined by Owner, to become property of Owner.
 - 1. Deliver molds carefully packed, protected from dirt, moisture, and breakage so as to arrive in usable, undamaged condition and enable long-term storage and possible future use.

2.09 QUALITY ASSURANCE

- A. Historic Treatment Specialist Qualifications: A qualified historic cast-iron repair specialist. Experience in repairing, brazing, and welding wrought iron, steel, or cuprous metals and installing and finishing new cast-iron work is insufficient experience for historic cast-iron repair work.
 - 1. Historic Brazing-and-Welding Specialist: A qualified brazing-and-welding-repair specialist experienced with these repairs on historic cast iron. Have the brazing-and-welding specialist work under direction of the historic treatment specialist.
 - 2. Historic Metal-Stitching Specialist: A qualified metal-stitching-repair specialist experienced with metal stitching of historic cast iron. Have the metal-stitching specialist work under direction of the historic treatment specialist.
 - 3. Single Specialist: Have the work of [Section 050371 "Historic Decorative Metal Cleaning"] [Section 050372 "Historic Decorative Metal Repair"] [Section 050373 "Historic Decorative Metal Refinishing"] [Section 050374 "Historic Decorative Metal Replication"] [and] [this Section] performed by the same historic treatment specialist firm, meeting the specialist qualifications of those Sections.
- B. Cast-Iron Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for historic cast-iron repair work, including each process or phase of repairing cast iron, related work, and the protection of surrounding materials and Project site.
 - 1. If materials and methods other than those indicated are proposed for any phase of historic treatment work, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.
- C. Mockups: Prepare mockups of historic treatment repair processes[on existing surfaces] to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation. Prepare mockups so they are inconspicuous.
 - 1. Repairing Metal Component: [Two] cast-iron [pinning] [and] [metal-stitching] repairs on sample pieces of cast iron.
 - 2. Replacing Metal Component: [Two] cast-iron [finials replaced on fence] [and] [wall registers] .
 - 3. Cast-Metal Components: Submit patterns, models, or plaster castings made from existing cast-iron item for each replacement casting required.
 - 4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

2.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with historic cast-iron repair only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 PRODUCTS

3.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design [railings] [handrails] [handrail brackets] [and] [anchors] according to structural performance requirements.
- B. Structural Performance: [Railings] [handrails] [and] [handrail brackets] , including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Uniform load of 50 lbf/ft. (0.73 kN/m) applied in any direction.
 - 2. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
 - 3. Uniform and concentrated loads need not be assumed to act concurrently.

3.02 METAL MATERIALS

- A. Provide metal materials made of the alloys, forms, and types that match existing metals and that have the ability to receive finishes matching existing finishes unless otherwise indicated. Exposed-to-view surfaces exhibiting imperfections inconsistent with existing materials are unacceptable.
- B. Source Limitation for Replacement Cast Materials: Obtain castings for cast-iron repair from single source from single manufacturer with resources to provide materials of consistent quality in appearance and physical properties.
- C. Cast Iron:
 - 1. Gray-Iron Castings: ASTM A48/A48M, Class 30.
 - 2. Malleable-Iron Castings: ASTM A47/A47M, grade as recommended in writing by fabricator for type of use indicated.
- D. Aluminum: Alloy and temper recommended in writing by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required:
 - 1. Extruded Structural Pipe and Tubing: ASTM B429/B429M, Alloy 6063-T6.
 - 2. Drawn Seamless Tubing: ASTM B210 (ASTM B210M), Alloy 6063-T832.
 - 3. Castings: ASTM B26/B26M, Alloy A356-T6.
- E. Copper Alloys, Bronze:
 - 1. Seamless Pipe: ASTM B43, Alloy UNS No. C23000 (red brass, 85 percent copper and 15 percent zinc).
 - 2. Seamless Tubes: ASTM B135 (ASTM B135M), Alloy UNS No. C23000 (red brass, 85 percent copper and 15 percent zinc).
- F. Copper Alloys, Brass:
 - 1. Seamless Tubes: ASTM B135 (ASTM B135M), Alloy UNS No. C26000 (cartridge brass, 70 percent copper and 30 percent zinc).
- G. Steel:
 - 1. Tubing: Cold formed, ASTM A500/A500M.

3.03 WOOD MATERIALS

- A. Wood Rails: Hardwood rails of species and profile indicated, with [transparent finish] , and prepared for securing to metal subrail or brackets as indicated on Drawings.
 - 1. Species and Finish: [Match design reference sample] [Match existing] [As indicated on Drawings] [Ash, natural finish] [Cherry, natural finish] [Walnut,

natural finish] [White oak, light-stained finish] .

2. Profile: [Match design reference sample] [Match existing] [As indicated on Drawings] [Square shape, 1-3/4 by 1-3/4 inches (45 by 45 mm), with edges eased to 1/4-inch (6-mm) radius] [Rectangular shape, 1-3/4 by 5 inches (45 by 127 mm), with edges eased to 1/4-inch (6-mm) radius] [Round shape, 2-inch (50-mm) diameter] .
- B. Wood Rails: Hardwood rails of species and profile [matching design reference sample] [matching existing] [as indicated on Drawings] , complying with [Section 050372 "Historic Decorative Metal Repair."] [Section 060312 "Historic Wood Repair."] [Section 064013 "Exterior Architectural Woodwork."] [Section 064023 "Interior Architectural Woodwork."]

3.04 PREPARATORY CLEANING MATERIALS

- A. Water: Potable.
- B. Hot Water: Water heated to a temperature of 140 to 160 deg F (60 to 71 deg C).
- C. Detergent Solution, Job Mixed: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium pyrophosphate (TSPP), 1/2 cup (125 mL) of laundry detergent, and 20 quarts (20 L) of hot water for every 5 gal. (20 L) of solution required.
- D. Abrasive Materials:
 1. Abrasive Pads: Non-scratch, of the following type(s):
 - a. Abrasive Pad with Sponge: Combination plastic abrasive pad, consisting of a sponge enclosed with a woven urethane, polypropylene, or other plastic mesh or fabric, without other abrasive components that can scratch metal.
 - b. Abrasive Pad of Plant Fibers: Agave, loofa, or another tough plant fiber, without other abrasive components that can scratch metal.
 2. Medium Abrasives for Ferrous Metals: Aluminum-oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes of various sizes.
 3. Medium Abrasives for Copper-Alloys: Extra-fine bronze wool or plastic abrasive pads.
 4. Blasting Abrasive: [Pulverized walnut shells] [Powdered aluminum silicate] .
- E. Wash Cloths: Lint-free, absorbent, durable cloth without abrasives that can scratch metal.
- F. Rust Remover: Manufacturer's standard phosphoric acid-based gel formulation, also called "naval jelly," for removing corrosion from iron and steel.

3.05 PINNING MATERIALS

- A. Pins: Threaded, stainless-steel rod, cut to length as required for each repair.
- B. Pinning Adhesive: Epoxy adhesive recommended in writing by adhesive manufacturer for bonding to cast iron.

3.06 METAL STITCHING MATERIALS

- 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. LOCK-N-Stitch Inc.
- B. Stitching Pins: Threaded steel screws sized for the thickness and condition of cast iron being repaired, with thread design that pulls the sides of a crack together, thereby both sealing the crack and adding strength to the repair.
- C. Locks: Multiple-dumbbell-shaped ties cut from steel sheet for installation in multiple thicknesses to add strength and distribute stresses in the cast iron as required for the thickness and condition of cast iron being repaired.

3.07 FASTENERS

- A. Fasteners: Fasteners of the same basic metal as fastened metal unless otherwise indicated. Use metals that are noncorrosive and compatible with each metal joined.

1. Match existing fasteners in material and in type of fastener unless otherwise indicated.
 2. Use concealed fasteners for interconnecting cast-iron components and for attaching them to other work unless exposed fasteners are [unavoidable] [or] [the existing fastening method].
 3. For exposed fasteners, use slotted machine screws of [hex-head profile] [head profile flush with metal surface] unless otherwise indicated[or another head is required to match the existing fastening method as determined by Architect].
 4. Finish heads of exposed fasteners to match finish of metal fastened unless otherwise indicated.
- B. Post-Installed Structural Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on [ICC-ES AC01] [ICC-ES AC193] [ICC-ES AC58] [or] [ICC-ES AC308] as appropriate for the substrate.
1. Uses: Securing [railings] [handrails] [and] [handrail brackets] to structure.
 2. Type: [Torque-controlled, expansion anchor] [torque-controlled, adhesive anchor] [or] [adhesive anchor].
 3. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941 (ASTM F1941M), Class Fe/Zn 5, unless otherwise indicated.
 4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [Group 1 (A1)] [Group 2 (A4)] stainless-steel bolts, ASTM F593 (ASTM F738M), and nuts, ASTM F594 (ASTM F836M).
- C. Post-Installed Nonstructural Anchors: Fastener systems with bolt heads of same basic metal as fastened metal, if visible, unless otherwise indicated; with an evaluation report acceptable to authorities having jurisdiction, based on [ICC-ES AC01] [ICC-ES AC193] [ICC-ES AC58] [or] [ICC-ES AC308] as appropriate for the substrate.
1. Type: [Expansion anchor] [adhesive anchor] [types matching existing] [or] [types indicated on Drawings].
 2. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941 (ASTM F1941M), Class Fe/Zn 5, unless otherwise indicated.
 3. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [Group 1 (A1)] [Group 2 (A4)] stainless-steel bolts, ASTM F593 (ASTM F738M), and nuts, ASTM F594 (ASTM F836M).

3.08 ACCESSORIES

- A. Metal-Patching Compound: Two-part, epoxy- or polyester-resin, metal-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of metal repair indicated, tooling time required for the detail of work, and site conditions. Compound shall be produced for filling cast iron that has deteriorated because of corrosion or deformation. Filler shall be capable of filling deep holes and spreading to feather edge.
- B. Brazing Rods for Cast Iron: Type and alloy as recommended in writing by brazing-rod manufacturer and as required for strength and compatibility with cast-iron items.
- C. Welding Electrodes and Filler Metal: Select according to AWS specifications for welding cast-iron; use compatible metal type and alloy as required for strength, and compatibility with cast-iron items.
- D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended in writing by manufacturer for interior and exterior applications.
- E. 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 in writing by manufacturer for

exterior use.

- F. Sealant Materials:
 - 1. Provide manufacturer's standard, elastomeric [nonstaining, single-component, nonsag silicone] [single-component, nonsag urethane] sealant complying with applicable requirements in Section 079200 "Joint Sealants."
 - 2. Colors: Provide colors of exposed sealants to match colors of metals in which sealant is placed unless otherwise indicated.
- G. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer according to [MPI #23 (surface tolerant, anticorrosive metal primer)] [or] [SSPC-Paint 20 or SSPC-Paint 29] .
 - 1. Surface Preparation: Use coating requiring no better than [SSPC-SP 2, "Hand Tool Cleaning,"] [SSPC-SP 3, "Power Tool Cleaning,"] [or] [SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning,"] surface preparation according to manufacturer's literature or certified statement.
 - 2. VOC Limit: Use coating with a VOC content of [400 g/L (3.3 lb/gal.)] or less.
- H. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- I. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline cleaners.
 - 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 Building Restoration Products, Inc.
 - b. PROSOCO, Inc.
 - c. Price Research, Ltd. dba Charles Paint Research.
- J. Masking Tape: Nonstaining, nonabsorbent material; compatible with chemical solutions being used and substrate surfaces, and that will easily come off entirely, including adhesive.
- K. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
 - 1. Previous effectiveness in performing the work involved.
 - 2. Little possibility of damaging exposed surfaces.
 - 3. Consistency of each application.
 - 4. Uniformity of the resulting overall appearance.
 - 5. Do not use products or tools that could do the following:
 - a. Remove, alter, or in any way harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in the Contract.
 - b. Leave an unintended residue on surfaces.

3.09 CAST-METAL FABRICATION

- 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. Allen Architectural Metals, Inc.
 - 2. Alloy Casting Co., Inc.
 - 3. Antique Cast Iron, LLC.
 - 4. Architectural Iron Company, Inc.
 - 5. Historical Arts & Casting, Inc.
 - 6. Olek Lejbzon & Co.
 - 7. Robinson Iron.
 - 8. Schiff Architectural Detail.
- B. Custom fabricate repairs of cast-iron items and components in sizes and profiles to match existing cast iron unless otherwise indicated, with accurate curves, lines, and angles. Mill joints

to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.

- C. Provide uniform, neat seams with minimum exposure of welds, brazing, and sealant.
- D. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for fasteners. Use concealed fasteners where possible; use exposed fasteners to match existing work.
- E. Comply with AWS for recommended practices in welding and brazing. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.
 - 1. Use materials and methods that minimize distortion, and develop maximum strength and corrosion resistance.
 - 2. Remove flux immediately.
 - 3. At exposed connections, match contours of adjoining surfaces, and finish exposed surfaces smooth and blended so no roughness shows after finishing.
- F. Castings: Fabricate castings free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.
 - 1. Finish castings to match existing cast-iron work.
 - 2. Replacement Casting for Handrail Bracket: Duplicate existing handrail bracket on the cast-iron railing of first-floor stairs in the lobby. Make molds from this bracket to create new cast-iron brackets.
- G. Date Identification: Emboss on a concealed, interior surface of the metal body of each new component, in easily read characters, "MADE ." Manufacturer's name may also be embossed. Add the identification to the mold pattern before casting.

3.10 FINISHES, GENERAL

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- 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.

3.11 ALUMINUM FINISHES

- A. Mill finish.
- B. Clear Anodic Finish: AAMA 611, [Class I, 0.018 mm] [Class II, 0.010 mm] or thicker over a [satin (directionally textured)] [polished (buffed)] [nonspecular as fabricated] mechanical finish.
- C. Color Anodic Finish: AAMA 611, [Class I, 0.018 mm] [Class II, 0.010 mm] or thicker over a [satin (directionally textured)] [polished (buffed)] [nonspecular as fabricated] mechanical finish.
- D. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, application, and baking.

3.12 COPPER-ALLOY FINISHES

- A. Finish designations for copper alloys comply with the system defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)."
- B. Buffed Finish: [M21 (Mechanical Finish: buffed, smooth specular)] [M22 (Mechanical Finish: buffed, specular)] .
- C. Buffed Finish, Lacquered: [M22 (Mechanical Finish: buffed, specular; specified clear organic coating)] .

- D. Satin Hand-Rubbed Finish: [M32-M34 (Mechanical Finish: directionally textured, medium satin and hand-rubbed)] .
- E. Satin Hand-Rubbed Finish, Lacquered: [M32-M34-06x (Mechanical Finish: directionally textured, medium satin and hand-rubbed; specified clear organic coating)] .
- F. Satin Finish with Statuary Conversion Coating: [M32-C55 (directionally textured, medium satin; sulfide conversion coating)] .
 - 1. Color: [Match design reference sample] [Match existing] [Match Architect's sample] .
- G. Brushed Finish with Patina Conversion Coating: M35-C12-C52 (directionally textured, rotary brushed and buff polished, nonetched cleaned; ammonium sulfate conversion coating).
 - 1. Texture and Color: [Match design reference sample] [Match existing] [Match Architect's sample] .
- H. Bright-Relieved Statuary Conversion Coating, Lacquered: M12-C55-M2x-06x (matte finish as cast; sulfide conversion coating; buffed to brighten high spots; specified clear organic coating):
 - 1. Color and Buffing: [Match design reference sample] [Match existing] [Match Architect's sample] .
- I. Patina Finish: .

3.13 FERROUS METAL FINISHES

- A. Repair Primer: Manufacturer's standard, rust-inhibiting, fast-curing, lead- and chromate-free universal primer, compatible with [firmly adhered existing paint and] applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
- B. Finish Primer: Primer complying with applicable requirements in [Section 090391 "Historic Treatment of Plain Painting"] for finish painting of primed metal.
- C. 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

4.01 HISTORIC TREATMENT SPECIALIST

- A. Historic Treatment Specialist Firms: Subject to compliance with requirements [provide historic cast-iron repair by one of the following] [firms that may provide historic cast-iron repair include, but are not limited to, the following]:
 - 1. .

4.02 PROTECTION

- A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.
 - 1. Cover adjacent surfaces with materials that are proved to resist chemical solutions being used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
 - 2. Do not apply chemical solutions during winds of enough force to spread them to unprotected surfaces.
 - 3. Neutralize alkaline and acid wastes before disposal.

4. Dispose of runoff from 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.

4.03 HISTORIC CAST-IRON REPAIR, GENERAL

- A. Repair Appearance Standard: Repaired surfaces are to have a uniform appearance as viewed from [20 feet (6 m)] [50 feet (15 m)] away by Architect.
- B. Execution of the Work: In repairing historic items, disturb remaining existing work as minimally as possible and as follows:
 1. Stabilize cast iron to reestablish structural integrity and weather resistance while maintaining the existing form of each item.
 2. Remove deteriorated coatings and corrosion.
 3. Sequence work to minimize time before protective coatings are reapplied.
 4. Repair items where stabilization is insufficient to stop progress of deterioration.
 5. Repair items in place unless otherwise indicated and retain as much original material as possible.
 6. Replace or reproduce historic items where indicated or scheduled.
 7. Make historic treatment of materials reversible whenever possible.
 8. Install temporary protective measures to stabilize cast iron that is indicated to be repaired later.
- C. Mechanical Coating Removal: Use gentlest mechanical methods, such as scraping and wire brushing, that do not abrade metal substrate. Do not use abrasive methods, such as sanding, or power tools except as indicated as part of the historic treatment program and approved by Architect.
- D. Repairing Cast-Iron Items: Match existing features, retaining as much original material as possible to complete the repair.
 1. Unless otherwise indicated, repair cast iron by patching, filling, piecing-in, splicing, or otherwise reinforcing the existing cast iron with new material matching existing.
 2. Where indicated, repair cast iron by limited replacement to the extent indicated, matching existing material.
- E. Replacing Cast-Iron Components: Where indicated, duplicate and replace items with new material matching existing.
 1. Replace heavily deteriorated or missing parts or features of cast iron with compatible materials, using surviving prototypes to create patterns or molds for duplicate replacements.
 2. Do not use substitute materials unless otherwise indicated.
 3. Compatible substitute materials may be used.

4.04 PREPARATORY CLEANING

- A. Perform preparatory cleaning before performing repair work.
 1. Brushes: If using wire brushes, use steel or stainless-steel brushes that are resistant to chemicals being used.
 2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.
 - a. Equip units with pressure gages.
 - b. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
 - c. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
 - d. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F (60 and 71 deg C) at flow rates indicated.
 3. Uniformity: Perform each cleaning method in a manner that results in uniform coverage of all surfaces, including corners, contours, and interstices, and that produces an even effect without streaks or damaging surfaces.

4. Protection: After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.
- B. Water Cleaning: Clean with [cold] [hot] water applied with [sponges or wash cloths] [low-pressure spray] [medium-pressure spray] [high-pressure spray]. Supplement with [natural-fiber] [or] [plastic] bristle brush[and abrasive pads]. Use small brushes to remove soil and loose paint from joints and crevices.
- C. Detergent Cleaning:
 1. Wet surface with [cold] [hot] water applied with [sponges or wash cloths] [low-pressure spray].
 2. Scrub surface with detergent solution and [natural-fiber] [or] [plastic] bristle brush[and abrasive pads] until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
 3. Rinse with [cold] [hot] water applied with [sponges or wash cloths] [low-pressure spray] [medium-pressure spray] [high-pressure spray] to remove detergent solution, soil, and loose paint.
- D. Cleaning by Abrasive Blasting: Clean surfaces to remove dirt and loose paint by dry blasting with specified blasting abrasive at pressure and distance from surface indicated below. [Rinse with cold water, low-pressure spray to remove residue; wipe with cloths to remove water] [Do not rinse cast iron with water; wipe with soft brushes and damp cloths to remove residue] .
 1. Pressure and Distance from Surface: Maximum pressure of [60 psi (415 kPa)] [100 psi (690 kPa)] [200 psi (1375 kPa)] with specified blasting abrasive propelled from a distance of [6 to 12 inches (152 to 305 mm)] [12 to 18 inches (305 to 457 mm)] from surface.
 2. Pressure and Distance from Surface: As established by mockup.
- E. Chemical Rust Removal:
 1. Remove loose rust scale with approved, medium abrasives for ferrous metals.
 2. Apply rust remover with brushes or as recommended in writing by manufacturer.
 3. Allow rust remover to remain on surface for period recommended in writing by manufacturer or as determined by testing. Do not allow extended dwell time.
 4. Wipe off residue with mineral spirits and either steel wool or soft rags, or clean with method recommended in writing by manufacturer to remove residue.
 5. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
 6. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.
- F. Mechanical Rust Removal:
 1. Remove rust with approved, medium abrasives for ferrous metals.
 2. Wipe off residue with mineral spirits and either steel wool or soft rags.
 3. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
 4. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

4.05 DISMANTLING, REPAIR, AND INSTALLATION

- A. Repair cast iron in place insofar as practicable unless otherwise indicated. Where necessary, dismantle components from their substrate and repair and reinstall according to approved historic treatment program.
- B. Perform dismantling work as required in Section 024296 "Historic Removal and Dismantling."
- C. Installation:
 1. Locate and place cast-iron items level and plumb and in alignment with adjacent construction.
 - a. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

2. Use concealed anchorages where possible unless otherwise indicated.
 3. Form tight joints with exposed connections accurately fitted together.
 4. Install concealed joint fillers, sealants, and flashings, as the Work progresses, to make exterior items weatherproof.
 5. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.
 6. Touch Up: At completion of installation, touch up and restore damaged or defaced finish surfaces and fastener heads.
- D. Reinstalling [Railing] [and] [Fence] Posts: After posts have been inserted in 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. Leave anchorage joint exposed, wipe off surplus anchoring material, and leave 1/8-inch (3-mm) buildup sloped away from post.
- E. Anchoring Wood Rails: Secure wood rails to cast-iron subrail or brackets from bottom of rail as indicated on Drawings. Make fastener heads flush to metal surface of subrail or brackets.
- F. Sealant: Clean and prepare joint surfaces and apply and cure sealant according to Section 079200 "Joint Sealants."
1. Keep joint surfaces to receive sealant dry and free of debris.
 2. [Prime joint surfaces unless sealant manufacturer recommends against priming.]Do not allow primer to spill or migrate onto adjoining surfaces.
 3. Apply sealant on joint surfaces between abutting cast-iron components in a continuous application immediately before joining the components together. Remove excess after components are joined and tightened.
 4. Fill sealant-type joints with specified joint sealant as recommended in writing by sealant manufacturer and the following:
 - a. Install sealant using only proved installation methods that ensure sealant is deposited in a uniform, continuous ribbon, without gaps or air pockets, and with complete wetting of the joint bond surfaces equally on both sides. Fill joint flush with surrounding metal.
 - b. Do not allow sealant to overflow or spill onto adjoining surfaces or to migrate into the voids of adjoining surfaces, particularly rough or sculptural textures. Promptly remove excess and spillage of sealant as the work progresses. Clean adjoining surfaces by means necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes, as demonstrated in an approved mockup.

4.06 FILLING DEFECTS IN PAINTED SURFACES

- A. Repair non-load-bearing defects in existing metal surfaces, including dents and gouges more than [1/16 inch (1.6 mm)] [1/8 inch (3 mm)] deep or [1/2 inch (13 mm)] [1 inch (25 mm)] across and all holes and tears by filling with metal-patching compound. Remove burrs. Prime iron and steel surfaces immediately after repair to prevent flash rusting.
1. Apply metal-patching compound to fill depressions, nicks, cuts, and other voids created by rusted, removed, or missing metal.
 2. Mix only as much patching compound as can be applied according to manufacturer's written instructions.
 3. Apply patching compound in layers of maximum 1/8-inch (3-mm) thickness and as recommended in writing by manufacturer until the void is completely filled.
 4. Finish patch surface smooth and shaped flush with adjacent contours, without voids in patch material.
 5. Clean spilled compound from adjacent materials immediately.

4.07 PINNING

- A. Use cast-iron piece that has broken-off or a custom, cast replica of a similar item. Verify that repair piece is a correct match for remaining existing work and of a size that can be pinned.
- B. Grind mating surfaces of base metal and repair piece along the repair seam to produce an accurate fit and alignment with the base assembly. Grind mating surfaces to produce joint size no larger than [1/32 inch (0.8 mm)] .
- C. Exposed Pinning: Before applying adhesive, prepare for mechanical anchorage consisting of 1/8-inch- (3-mm-) diameter, threaded stainless-steel pins set into 3/16-inch- (4.5-mm-) diameter holes drilled at through face of repair piece and into base metal.[Insert pins at least 1 inch (25 mm) into base metal and 1 inch (25 mm) into repair piece with end countersunk at least 1/4 inch (6 mm) from exposed face of repair piece.] [For large pieces, center and space pins 3 inches (75 mm) apart and at least 1/4 inch (6 mm) from any edge.]
- D. Concealed Pinning: Before applying adhesive, prepare for concealed mechanical anchorage consisting of 1/8-inch- (3-mm-) diameter, threaded stainless-steel pins set into aligned, 3/16-inch- (4.5-mm-) diameter holes drilled into base metal and into, but not through, the repair piece.[Insert pins at least 1 inch (25 mm) into base metal and 1 inch (25 mm) into repair piece.] [For large pieces, center and space pins 3 inches (75 mm) apart and at least 1/4 inch (6 mm) from any edge.]
- E. Apply pinning adhesive according to adhesive manufacturer's written instructions. Fill holes and coat bonding surfaces of base metal and repair piece.
- F. Apply repair piece while adhesive is fresh and hold securely in place until adhesive has cured. Use temporary shims, clamps, wedges, or other devices as necessary to keep repair piece and base metal aligned.
- G. Clean adhesive residue from exposed surfaces[and fill exposed drill holes] as specified in "Filling Defects in Painted Surfaces" Article.

4.08 METAL STITCHING

- A. Install metal stitching materials according to written instructions of metal-stitching-system manufacturer for the thickness and condition of cast iron being repaired.
- B. Drill, tap, and install metal stitching pins along entire length of crack being repaired, overlapping the pins to ensure complete sealing and pulling together of sides of the crack.
- C. Cut slots shaped and sized to hold locks. Do not cut slots deeper than 90 percent of the thickness of the cast iron.
- D. Install locks with [three large lobes] [seven large lobes] [number of lobes] and spaced as recommended in writing by metal-stitching-system manufacturer for each lock location. Install locks in [two] [three] layers unless otherwise recommended in writing by metal-stitching-system manufacturer.
- E. Grind off metal-stitching materials that project above surface of cast iron without damaging cast-iron surface.

4.09 PRIMING

- A. Repair Primer: Apply immediately after completing a repair.
- B. Finish Primer: Apply as soon after cleaning as possible.

4.10 PAINTING STEEL UNCOVERED DURING THE WORK

- A. Notify Architect if steel is exposed during metal repair or removal. Where Architect determines that the steel is structural, or for other reasons cannot be totally removed, prepare and paint it as follows:
 - 1. Surface Preparation: Remove paint, rust, and other contaminants according to [SSPC-SP 2, "Hand Tool Cleaning,"] [SSPC-SP 3, "Power Tool Cleaning,"] [or] [SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning,"] as applicable to comply

- with paint manufacturer's recommended preparation.
2. Antirust Coating: Immediately paint exposed steel with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended rate of application (dry film thickness per coat).
- B. If on inspection and rust removal the thickness of a steel member is found to be reduced from rust by more than [1/16 inch (1.6 mm)] , notify Architect before proceeding.

4.11 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.
- B. Notify testing agency in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until inspectors have had reasonable opportunity to inspect work areas at locations of lift devices or scaffolding.

4.12 HISTORIC CAST-IRON REPAIR SCHEDULE

- A. Treatment of Cast-Iron Railing [CIR-1] : Cast-iron railing and gate.
 1. Perform work [in the shop] [or] [in the field].
 2. Paint Removal: As specified in Section 050371 "Historic Decorative Metal Cleaning."
 3. Repairs: Repair broken railing finials by pinning, and replace missing components with custom, cast-[iron] [aluminum] components.
 4. Painted Finish: As specified in [Section 090391 "Historic Treatment of Plain Painting."]
 5. Baked-Enamel or Powder-Coat Finish: [Color as indicated by manufacturer's designations] [Color matching design reference sample] [Color matching Architect's sample] [Color as selected by Architect from manufacturer's full range]
 6. Gilding: As specified in [Section 090398 "Historic Treatment of Gilding."]
- B. Treatment of Cast-Iron Railing [CIR-2] : Cast-iron balustrade.
 1. Perform work [in the shop] [or] [in the field].
 2. Paint Removal: As specified in Section 050371 "Historic Decorative Metal Cleaning."
 3. Rust Removal: [Chemical] [Mechanical] .
 4. Repair: [Patch with new material by filling, metal stitching, or replacing cast-iron components with new castings and fasteners] .
 5. Painted Finish: As specified in [Section 090391 "Historic Treatment of Plain Painting."]
 6. Gilding: As specified in [Section 090398 "Historic Treatment of Gilding."]
- C. Treatment of Cast-Iron Railing and Handrail [CIRH-1] : Cast-iron railing with bronze handrail.
 1. Perform work [in the shop] [or] [in the field].
 2. Cleaning: As specified in Section 050371 "Historic Decorative Metal Cleaning."
 3. Repair: [Patch cast iron with new material by filling, metal stitching, or replacing cast-iron components with new castings and fasteners] .
 - a. Replicate cast-iron as specified in Section 050374 "Historic Decorative Metal Replication."
 4. Painted Finish: As specified in [Section 090391 "Historic Treatment of Plain Painting."]
 5. Bronze Finish: [Satin finish with statuary conversion coating on railing; satin hand-rubbed finish, lacquered, on handrail] .

- D. Treatment of Cast-Iron Railing and Handrail [CIRH-2] : Deteriorated [bronze] [wood] handrail on cast-iron railing.
1. Repair: Replace broken cast-iron railing components and repaint railing. Replace entire, deteriorated [bronze] [wood] handrail with shop-fabricated [aluminum] [steel] [wood] handrail. Replicate cast-iron as specified in Section 050374 "Historic Decorative Metal Replication."
 2. Paint Removal: As specified in Section 050371 "Historic Decorative Metal Cleaning."
 3. Railing Finish: Paint as specified in [Section 090391 "Historic Treatment of Plain Painting."]
 - a. Color: [As indicated by manufacturer's designations] [Matching design reference sample] [Matching Architect's sample] [As selected by Architect from manufacturer's full range] .
 4. Gilding: As specified in [Section 090398 "Historic Treatment of Gilding."]
 5. Handrail Finish:
 - a. Aluminum Finish: [Light bronze anodized] [Medium bronze anodized] [Dark bronze anodized] [Anodized color matching design reference sample] [Anodized color matching Architect's sample] [Anodized color as selected by Architect from full range of industry colors and color densities] .
 - b. Baked-Enamel or Powder-Coat Finish: [Color as indicated by manufacturer's designations] [Color matching design reference sample] [Color matching Architect's sample] [Color as selected by Architect from manufacturer's full range] .
- E. Treatment of Cast-Iron Facade and Storefront [CIFS-#] : Repair facade and storefront and replace missing components.
1. Perform work [in the shop] [or] [in the field].
 2. Dismantle and Salvage Items: Dismantle the following[, return to shop to perform indicated treatment of item,] and deliver to Owner for storage for future installation:
 - a. Cast-iron medallions.
 - b. .
 3. Cleaning: As specified in Section 050371 "Historic Decorative Metal Cleaning."
 4. Paint Removal: As specified in Section 050371 "Historic Decorative Metal Cleaning."
 5. Rust Removal: [Chemical] [Mechanical] .
 6. Repair: [Patch with new material by filling, pinning pieces of broken ornaments, metal stitching cracks, or replacing cast-iron components with new castings and fasteners] [Splice new material into deteriorated section] [Reinforce] [Refasten] [Realign] .
 - a. Replace with new duplicate of existing item. .
 - b. Replicate cast iron as specified in Section 050374 "Historic Decorative Metal Replication."
 - c. Seal joints between components unless otherwise indicated; install sealant-type joints where indicated on Drawings.
 7. Finish Treatment:
 - a. Painted Finish: As specified in [Section 090391 "Historic Treatment of Plain Painting."]
 - b. Gilding: As specified in [Section 090398 "Historic Treatment of Gilding."]

END OF SECTION 050383

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SECTION 051200 STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Structural steel framing members.
- B. Grouting under base plates.

1.02 RELATED REQUIREMENTS

- A. Section 053100 - Steel Decking: Support framing for small openings in deck.

1.03 REFERENCE STANDARDS

- A. AISC (MAN) - Steel Construction Manual 2017.
- B. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges 2016.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.
- E. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished 2018.
- F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- G. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- H. ASTM A242/A242M - Standard Specification for High-Strength Low-Alloy Structural Steel 2013 (Reapproved 2018).
- I. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength 2021.
- J. ASTM A449 - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use 2014 (Reapproved 2020).
- K. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes 2021a.
- L. ASTM A529/A529M - Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality 2019.
- M. ASTM A563/A563M - Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric) 2021a.
- N. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel 2021, with Editorial Revision.
- O. ASTM A588/A588M - Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance 2019.
- P. ASTM A992/A992M - Standard Specification for Structural Steel Shapes 2020.
- Q. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable 2021a.
- R. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength 2018a.
- S. ASTM C827/C827M - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures 2016.
- T. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) 2020.

- U. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.
- V. ASTM E94/E94M - Standard Guide for Radiographic Examination Using Industrial Radiographic Film 2017.
- W. ASTM E164 - Standard Practice for Contact Ultrasonic Testing of Weldments 2019.
- X. ASTM E165/E165M - Standard Practice for Liquid Penetrant Testing for General Industry 2018.
- Y. ASTM E709 - Standard Guide for Magnetic Particle Testing 2021.
- Z. ASTM F436/F436M - Standard Specification for Hardened Steel Washers Inch and Metric Dimensions 2019.
- AA. ASTM F959/F959M - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series 2017a.
- BB. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength 2020.
- CC. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength 2022.
- DD. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination 2020.
- EE. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification 2021.
- FF. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2022).
- GG. RCSC (HSBOLT) - Specification for Structural Joints Using High-Strength Bolts; Research Council on Structural Connections 2020.
- HH. SSPC-SP 1 - Solvent Cleaning 2015, with Editorial Revision (2016).
- II. SSPC-SP 2 - Hand Tool Cleaning 2018.
- JJ. SSPC-SP 3 - Power Tool Cleaning 2018.
- KK. UL (FRD) - Fire Resistance Directory Current Edition.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
 - 2. Connections not detailed.
 - 3. Indicate cambers and loads.
 - 4. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.
- C. Manufacturer's Mill Certificate: Certify that products meet or exceed specified requirements.
- D. Mill Test Reports: Indicate structural strength, destructive test analysis and non-destructive test analysis.
- E. Fabricator Test Reports: Comply with ASTM A1011/A1011M.
- F. Materials Test Reports: Submit independent test results or engineered performance analysis of structural thermal-break pad performance in bearing or slip-critical connections where shear and moment loads are applied.
- G. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.
- H. Designer's Qualification Statement.
- I. Fabricator's Qualification Statement.

1.05 QUALITY ASSURANCE

- A. Fabricate structural steel members in accordance with AISC (MAN) "Steel Construction Manual."
- B. Maintain one copy of each document on site.
- C. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and no more than 12 months before start of scheduled welding work.
- D. Design connections not detailed on drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in Utah.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Comply with UL (FRD) Assembly Design No. ____.

2.02 MATERIALS

- A. Steel Angles and Plates: ASTM A36/A36M, see Structural Drawings for specific locations of Grade 50 plates.
- B. Steel W Shapes and Tees: ASTM A992/A992M.
- C. Rolled Steel Structural Shapes: ASTM A992/A992M.
- D. Cold-Formed Hollow Structural Sections: **ASTM A500/A500M, Grade C** structural tubing.
- E. Steel Plates and Bars: ASTM A572/A572M, Grade 50 (345) high-strength, columbium-vanadium steel.
- F. Shear Stud Connectors: Made from ASTM A108 Grade 1015 bars.
- G. Tension Control Bolts: Twist-off type; ASTM F3125/F3125M.
- H. Unheaded Anchor Rods: ASTM F1554, Grade 36, plain, with matching ASTM A563/A563M nuts and ASTM F436/F436M Type 1 washers.
- I. Headed Anchor Rods: ASTM F1554 Grade 36, plain.
- J. Load Indicator Washers: Provide washers complying with ASTM F959/F959M at connections requiring high-strength bolts.
- K. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- L. Grout: ASTM C1107/C1107M; Non-shrink; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
 - 1. Minimum Compressive Strength at 48 Hours: 2,000 pounds per square inch (13.7 MPa).
 - 2. Minimum Compressive Strength at 28 Days: 7,000 pounds per square inch (48 MPa).
 - 3. Height Change, Plastic State; when tested according to ASTM C827/C827M:
 - a. Maximum: Plus 4 percent.
 - b. Minimum: Plus 1 percent.
- M. Shop and Touch-Up Primer: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.
- N. Touch-Up Primer for Galvanized Surfaces: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

2.03 FABRICATION

- A. Shop fabricate to greatest extent possible.
- B. Space shear stud connectors at spacing indicated on structural drawings
- C. Continuously seal joined members by continuous welds. Grind exposed welds smooth.
- D. Fabricate connections for bolt, nut, and washer connectors.
- E. Develop required camber for members.

2.04 FINISH

- A. Prepare structural component surfaces in accordance with SSPC-SP 3.
- B. Shop prime structural steel members. Do not prime surfaces that will be fireproofed, field welded, in contact with concrete, or high strength bolted.
- C. Leave structural steel members un-primed.
- D. Galvanize structural steel members to comply with ASTM A123/A123M. Provide minimum 1.7 oz/sq ft galvanized coating. (Provide minimum 530 g/sq m galvanized coating.)

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that conditions are appropriate for erection of structural steel and that the work may properly proceed.

3.02 ERECTION

- A. Erect structural steel in compliance with AISC 303.
- B. Allow for erection loads and provide sufficient temporary bracing to maintain structure in safe condition, plumb, and in true alignment until completion of erection and installation of permanent bracing.
- C. Field weld components and shear studs indicated on shop drawings.
- D. Use carbon steel bolts only for temporary bracing during construction, unless otherwise specifically permitted on drawings. Install high-strength bolts in accordance with RCSC (HSBOLT) "Specification for Structural Joints Using High-Strength Bolts".
- E. Do not field cut or alter structural members without approval of Architect.
- F. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.
- G. Grout solidly between column plates and bearing surfaces, complying with manufacturer's instructions for nonshrink grout. Trowel grouted surfaces smooth, splaying neatly to 45 degrees.

3.03 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch (6 mm) per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch (6 mm).

3.04 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.
- B. High-Strength Bolts: Provide testing and verification of field-bolted connections in accordance with RCSC (HSBOLT) "Specification for Structural Joints Using High-Strength Bolts," testing at least ____ percent of bolts at each connection.

END OF SECTION 051200

SECTION 054000 COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Formed steel stud interior wall framing.

1.02 RELATED REQUIREMENTS

- A. Section 092116 - Gypsum Board Assemblies: Lightweight, non-load bearing metal stud framing.
- B. Section 092300 - Gypsum Plastering.

1.03 REFERENCE STANDARDS

- A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members 2016, with Supplement (2020).
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- C. ASTM C955 - Standard Specification for Cold-Formed Steel Structural Framing Members 2018, with Editorial Revision.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on standard framing members; describe materials and finish, product criteria, limitations and _____.
- C. Shop Drawings: Indicate component details, framed openings, bearing, anchorage, loading, welds, and type and location of fasteners, and accessories or items required of related work.
 - 1. Describe method for securing studs to tracks and for bolted framing connections.
 - 2. Design data:

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Metal Framing:
 - 1. CEMCO; _____: www.cemcosteel.com/#sle.
 - 2. ClarkDietrich; _____: www.clarkdietrich.com/#sle.
 - 3. Jaimes Industries; _____: www.jaimesind.com/#sle.
 - 4. MarinoWARE; _____: www.marinoware.com/#sle.
 - 5. SCAFCO Corporation; _____: www.scafco.com/#sle.
 - 6. Steel Construction Systems; _____: www.steelconstsystems.com/#sle.
 - 7. The Steel Network, Inc; _____: www.SteelNetwork.com/#sle.
 - 8. Substitutions: See Section 016000 - Product Requirements.

2.02 FRAMING SYSTEM

- A. Provide primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings as required to provide a complete framing system.
- B. Shop Drawing Submittal Requirements: Provide complete shop drawings indication size, location and connections of all cold form metal f
 - 1. Connections: Must be clearly indicated and noted on shop drawings
 - 2. Members: Material thickness and dimensions must be clearly noted on shop drawings
 - 3.
 - 4. Des
 - 5.
 - 6. Able to tolerate movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.

7. Able to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

2.03 FRAMING MATERIALS

- A. Studs and Track: ASTM C955; track in matching nominal width and compatible height.
 1. Galvanized in accordance with ASTM A653/A653M, G90/Z275 coating.

END OF SECTION 054000

**SECTION 055000
METAL FABRICATIONS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Shop fabricated steel and catwalk items.

1.02 RELATED REQUIREMENTS

- A. Section 051200 - Structural Steel Framing: Structural steel column anchor bolts.
- B. Section 055316 - Plank Grating: Delegated design for catwalk construction (Unitstrut)
- C. Section 055100 - Metal Stairs.
- D. Section 055133 - Metal Ladders.

1.03 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.
- C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- D. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength 2021.
- E. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes 2021a.
- F. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing 2021.
- G. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- H. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2022).
- I. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic) 2019.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 - 1. Design data: Submit drawings and supporting calculations, signed and sealed by a qualified professional structural engineer.
 - a. Include the following, as applicable:
 - 1) Design criteria.
 - 2) Engineering analysis depicting stresses and deflections.
 - 3) Member sizes and gauges.
 - 4) Details of connections.
 - 5) Support reactions.
 - 6) Bracing requirements.
- C. Designer's Qualification Statement.

1.05 QUALITY ASSURANCE

- A. Design _____ under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in Utah.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturer includes but is not limited to:
 - 1. Unistrut Corporation www.unistrutohio.com. Basis of design: Unistrut Interlock

2.02 MATERIALS - STEEL

- A. Steel Sections: ASTM A36/A36M.
- B. Steel Tubing: ASTM A501/A501M hot-formed structural tubing.
- C. Bolts, Nuts, and Washers: ASTM A307, Grade A, plain.
- D. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.03 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- D. Furnish components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.04 FINISHES - STEEL

- A. Galvanizing of Structural Steel Members: Galvanize after fabrication to ASTM A123/A123M requirements. Provide minimum 1.7 oz/sq ft galvanized coating. (Provide minimum 530 g/sq m galvanized coating.)
- B. Galvanizing of Non-structural Items: Galvanize after fabrication to ASTM A123/A123M requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.02 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Obtain approval prior to site cutting or making adjustments not scheduled.

END OF SECTION 055000

**SECTION 055100
METAL STAIRS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Stairs with concrete treads.
- B. Stairs with metal treads.
- C. Structural steel stair framing and supports.
- D. Handrails and guards.

1.02 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete fill in stair pans; mesh reinforcement for landings.
- B. Section 033000 - Cast-in-Place Concrete: Placement of metal anchors in concrete.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- B. AISC 201 - AISC Certification Program for Structural Steel Fabricators, Standard for Steel Building Structures 2006.
- C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- D. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination 2020.
- E. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification 2021.
- F. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2022).
- G. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel AC172 2019.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
 - 2. Include the design engineer's seal and signature on each sheet of shop drawings.
- C. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.
- D. Designer's Qualification Statement.
- E. Fabricator's Qualification Statement: Fabricator may provide shop fabrication inspection and testing in compliance with the requirements of the design documents.

1.05 QUALITY ASSURANCE

- A. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and dated no more than 12 months before start of scheduled welding work.
- B. Fabricator Qualifications:
 - 1. A qualified steel fabricator that is certified by the American Institute for Steel Construction (AISC) under AISC 201.
 - 2. A qualified steel fabricator that is accredited by the International Accreditation Service (IAS) Fabricator Inspection Program for Structural Steel in accordance with IAS AC172.
 - 3. A company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.

PART 2 PRODUCTS

2.01 METAL STAIRS - GENERAL

- A. Metal Stairs: Provide stairs of the design specified, complete with landing platforms, vertical and horizontal supports, railings, and guards, fabricated accurately for anchorage to each other and to building structure.
 - 1. Regulatory Requirements: Provide stairs and railings that comply with most stringent requirements of local, state, and federal regulations; where requirements of Contract Documents exceed those of regulations, comply with Contract Documents.
 - 2. Handrails: Comply with applicable accessibility requirements of ADA Standards.
 - 3. Dimensions: As indicated on drawings.
 - 4. Shop assemble components; disassemble into largest practical sections suitable for transport and access to site.
 - 5. No sharp or rough areas on exposed travel surfaces and surfaces accessible to touch.
 - 6. Separate dissimilar metals using paint or permanent tape.
- B. Metal Jointing and Finish Quality Levels:
- C. Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.
- D. Anchors and Related Components: Same material and finish as item to be anchored, except where specifically indicated otherwise; provide all anchors and fasteners required.

2.02 HANDRAILS AND GUARDS

- A. Wall-Mounted Rails: Round pipe or tube rails unless otherwise indicated.
 - 1. Outside Diameter: 1-1/4 inch (32 mm), minimum, to 1-1/2 inches (38 mm), maximum.
- B. Guards:
 - 1. Top Rails: Round pipe or tube rails unless otherwise indicated.
 - a. Outside Diameter: 1-1/4 inch (32 mm), minimum, to 1-1/2 inches (38 mm), maximum.
 - 2. End and Intermediate Posts: Same material and size as top rails.
 - a. Horizontal Spacing: As indicated on drawings.
 - b. Mounting: Welded to top surface of stringer.

END OF SECTION 055100

**SECTION 055133
METAL LADDERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Shop-fabricated metal ladders.

1.02 RELATED REQUIREMENTS

- A. Section 055100 - Metal Stairs.
- B. Section 099123 - Interior Painting: Paint finish.

1.03 REFERENCE STANDARDS

- A. 29 CFR 1910.23 - Ladders Current Edition.
- B. 29 CFR 1926.1053 - Ladders Current Edition.
- C. ANSI A14.3 - American National Standard for Ladders -- Fixed -- Safety Requirements 2008 (Reaffirmed 2018).
- D. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- E. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.
- G. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates 2018.
- H. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength 2021.
- I. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing 2021.
- J. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- K. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination 2020.
- L. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2022).
- M. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer 2004.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 - 2. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

1.05 QUALITY ASSURANCE

- A. Design _____ under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in Utah.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

- A. Steel Sections: ASTM A36/A36M.
- B. Steel Tubing: ASTM A501/A501M hot-formed structural tubing.
- C. Plates: ASTM A283/A283M.

- D. Pipe: ASTM A53/A53M, Grade B Schedule 40, black finish.
- E. Mechanical Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.
- F. Bolts, Nuts, and Washers: ASTM A307, plain.
- G. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- H. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- D. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.03 FABRICATED LADDERS

- A. Ladders: Steel; in compliance with ANSI A14.3; with mounting brackets and attachments; prime paint finish.
 - 1. Side Rails: 3/8 by 2 inches (9 by 50 mm) members spaced at 20 inches (500 mm).
 - 2. Rungs: One inch (25 mm) diameter solid round bar spaced 12 inches (300 mm) on center.
 - 3. Space rungs 7 inches (175 mm) from wall surface.

2.04 FINISHES - STEEL

- A. Prime paint steel items.
- B. Prime Painting: One coat.

2.05 FABRICATION TOLERANCES

- A. Squareness: 1/8 inch (3 mm) maximum difference in diagonal measurements.
- B. Maximum Offset Between Faces: 1/16 inch (1.5 mm).
- C. Maximum Misalignment of Adjacent Members: 1/16 inch (1.5 mm).
- D. Maximum Bow: 1/8 inch (3 mm) in 48 inches (1.2 m).
- E. Maximum Deviation From Plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.02 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Obtain approval prior to site cutting or making adjustments not scheduled.

END OF SECTION 055133

**SECTION 055316
PLANK GRATINGS**

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Formed-metal plank gratings
 - 2. Secondary catwalk fabrication.
 - 3. Catwalk Guards and Supports.
- B. Related Requirements:
 - 1. Section 051200 "Structural Steel Framing" for structural-steel framing system components.

1.02 ACTION SUBMITTALS

- A. Product Data:
 - 1. Formed-metal plank gratings.
 - 2. Layout of secondary supports including but not limited to:
 - a. Lateral and cross supports
 - b. Connectors and clamps
 - c. Railings and guards
 - d. Other items necessary for a complete installations.
- B. Shop Drawings:
 - 1. Include plans, sections, and attachment details.
 - 2. Signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Delegated Design Submittals: For gratings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.03 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: 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.
- B. Delegated design engineer qualifications.

1.04 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Delegated Design Engineer: A professional engineer who is legally qualified to practice in Utah where Project is located and who is experienced in providing engineering services of the type indicated.
 - 2. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:
 - a. AWS D1.1/D1.1M.

1.05 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design gratings.
- B. Structural Performance: Gratings to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Walkways and Elevated Platforms Other Than Exits: Uniform load of 60 lbf/sq. ft. (2.87 kN/sq. m).

- C. Seismic Performance: Gratings to withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. Component Importance Factor: 1.5.

2.02 FORMED-METAL PLANK GRATINGS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Unistrut; Atkore International; or a comparable product by one of the following:
 - 1. AMICO, a Gibraltar Industries company.
 - 2. Cooper B-line; brand of Eaton, Electrical Sector.
 - 3. Fisher & Ludlow; a Nucor company.
 - 4. Grating Pacific, Inc.
 - 5. IKG.
 - 6. Metalex.
- B. C-Shaped Channels: Rolled from heavy sheet metal of thickness indicated, and punched in serrated diamond shape to produce raised slip-resistant surface and drainage holes.
 - 1. Channel Width: As required to comply with structural performance requirements.
 - 2. Channel Depth: As required to comply with structural performance requirements.
 - 3. Material 0.079-inch- (2.0-mm-) thick, hot-dip galvanized-steel sheet

2.03 GRATING FRAMES AND SUPPORTS

- A. Frames and Supports: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
 - 1. Unless otherwise indicated, fabricate from same basic metal as gratings.
 - 2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches (600 mm) o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches (32 mm) wide by 1/4 inch (6.4 mm) thick by 8 inches (200 mm) long.
- B. Galvanize steel frames and supports in the following locations:
 - 1. Interior.

2.04 SAFETY RAILING

- A. Guardrail sections:
 - 1. Rails: 1-5/8 inches (41 mm) O.D. tubing , free of sharp edges and snag points.
 - 2. Height: 42 inches (1067 mm) above finished roof or platform.
 - 3. Mid rail: Weld to posts at 21 inches (533 mm) below top rail.
 - 4. Finish: Hot dip galvanized.
- B. Base plates:
 - 1. Material: Mild steel.
 - 2. Size: 10 inches x 30 inches x 0.625 inches with hand hole and radius corners.
 - 3. Weight: Shall not exceed 60 pounds per base plate.
 - 4. Base Plate Receivers: Two, built in to accept guardrail sections secured by stainless steel set screws. Receivers shall have drain holes.
 - 5. Finish: Hot dipped galvanized.
- C. Toe Boards
 - 1. Capable of withstanding without failure, a force of at least 50 pounds applied in any downward or outward direction at any point along the toeboard.
 - 2. Material: 3.5 inch minimum height with note more than 1/4 inch clearance above the walking/working surface.
 - 3. Attachment: Toe boards shall be integrated into baseplate receivers for a no-drill installation.

2.05 FASTENERS

- A. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A (ISO 898-1, Property Class 4.6); with hex nuts, ASTM A563 (ASTM A563M); and, where indicated, flat washers.
- B. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563 (ASTM A563M); and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- C. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.

2.06 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

2.07 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Uncoated Steel Sheet: ASTM A1011/A1011M, structural steel, Grade 30 (Grade 205).
- C. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, Grade 33 (Grade 230), with G90 (Z275) coating.

2.08 FABRICATION

- A. Cut, drill, and punch material 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.
- B. Fit exposed connections accurately together to form hairline joints.
- C. Welding: Comply with AWS recommendations and 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.
- D. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.
 - 1. Fabricate toeplates for attaching in the field.
 - 2. Toeplate Height: 4 inches (100 mm) unless otherwise indicated.
- E. Fabricate cutouts in grating sections for penetrations of sizes and at locations indicated. Cut openings neatly and accurately to size. Edge-band openings with metal sheet or bars having a thickness not less than grating material.
 - 1. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
- F. Where gratings are pierced by pipes, ducts, and structural members, cut openings neatly and accurately to size and weld a strap collar not less than 1/8 inch (3.2 mm) thick to the cut ends. Divide panels into sections only to extent required for installation where grating platforms and runways are to be placed around previously installed pipe, ducts, and structural members.

2.09 STEEL FINISHES

- A. Finish gratings, frames, and supports after assembly.
- B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings 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 gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
- C. Attach toeplates to gratings by bolting.
- D. Field Welding: Comply with AWS recommendations and the following:
 - 1. Minimize field welding and not permitted in attic or other enclosed spaces.
 - 2. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 3. Obtain fusion without undercut or overlap.
 - 4. Remove welding flux immediately.

3.02 INSTALLATION OF METAL PLANK GRATINGS

- A. Comply with manufacturer's written instructions for installing gratings. Use manufacturer's standard anchor clips and hold-down devices for bolted connections.
- B. Attach removable units to supporting members by bolting at every point of contact.
- C. Attach nonremovable units to supporting members by welding unless otherwise indicated. Comply with manufacturer's written instructions for size and spacing of welds.

3.03 REPAIR

- A. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055316

SECTION 060312 HISTORIC WOOD REPAIR

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes historic treatment of wood in the form of repairing wood features as follows:
 - 1. Repairing wood paneling, railings, and trim.
 - 2. Replacing wood paneling and.
 - 3. Repairing, refinishing, and replacing hardware.
- B. Related Requirements:
 - 1. Section 013591 "Historic Treatment Procedures" for general historic treatment requirements.
 - 2. Section 024296 "Historic Removal and Dismantling" for historic removal and dismantling work.
 - 3. Section 080314 "Historic Treatment of Wood Doors" for historic wood door repairs, including related trim.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to historic wood repair, including, but not limited to, the following:
 - a. Historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.
 - c. Fire-protection plan.
 - d. Wood historic treatment program.
 - e. Coordination with building occupants.

1.03 SEQUENCING AND SCHEDULING

- A. The intent of historic wood refinishing is to have a light touch, maintaining their historic look while bringing them to a "like new" condition.
- B. Perform historic wood repair to non-painted wood in the following sequence, which includes work specified in this and other Sections:
 - 1. Before removing wood components for on-site or off-site repair, tag each component with location-identification numbers. Indicate on tags and building plans the locations of each component, such as "Baseboard on North Side of Room 101."
 - 2. Dismantle hardware and tag with location-identification numbers.
 - 3. In the shop, label each repaired component and whole or partial replacement with permanent location-identification number in inconspicuous location and remove site-applied tags.
 - 4. Sort units by condition, separating those that need extensive repair. Those needing extensive repair are to be brought to the attention of the Architect.
 - 5. Clean surfaces.
 - 6. General Wood-Repair and Refinish Sequence:
 - a. Light sanding. Do not sand through existing finish if it still exists.
 - b. Repair deep gouges and any nail holes with wood filler. Sand.
 - c. Replace broken glass with tempered safety glazing.
 - d. For extensive decay or damage to doors only:
 - 1) Repair wood by consolidation, replacement, partial replacement, and patching.
 - 2) Sand, prime, fill, sand again, and prime surfaces again for refinishing.
 - 7. Apply 2 clear finish coats.
 - 8. Clean and repair hardware to an operating condition. Reinstall operating hardware.
 - 9. Reinstall components.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include recommendations for product application and use. Include test data substantiating that products comply with requirements.
- B. Shop Drawings:
 - 1. Include plans, elevations, and sections showing locations and extent of repair and replacement work, with enlarged details of replacement parts indicating materials, profiles, joinery, reinforcing, method of splicing or attaching wood members to other surfaces, accessory items, and finishes.
 - 2. Include field-verified dimensions and the following:
 - a. Full-size shapes and profiles with complete dimensions for replacement components and their jointing, showing relationship of existing components to new components.
 - b. Templates and directions for installing hardware and anchorages.
 - c. Identification of each new unit and its corresponding location in the building on annotated plans and elevations.
- C. Samples for Initial Selection: For each type of exposed wood and finish.
 - 1. Identify wood species, cut, and other features.
 - 2. Include Samples of hardware and accessories involving color selection.
- D. Samples for Verification: Actual sample of finished products for the following products in manufacturer's standard sizes unless otherwise indicated:
 - 1. Replacement Wood: 12-inch-long, full-size molding sections with applied finish.
 - a. Additional Samples of replacement members that show fabrication techniques, materials, and finishes as requested by Architect.
 - 2. Repaired Wood: Prepare Samples using existing wood removed from site, repaired, and prepared for refinishing.
 - 3. Refinished Wood: Prepare Samples using existing wood removed from site, repaired, and refinished.
 - 4. Hardware: Full-size units with each factory-applied or restored finish.

1.05 INFORMATIONAL SUBMITTALS

- A. Preconstruction Test Reports: For historic wood repair.
- B. Qualification Statements: For historic treatment specialist.
- C. Wood Historic Treatment Program: Submit before work begins.

1.06 QUALITY ASSURANCE

- A. Historic Treatment Specialist Qualifications: A qualified historic wood-repair specialist, experienced in repairing, refinishing, and replacing wood in whole and in part. Experience only in fabricating and installing new woodwork is insufficient experience for wood historic treatment work.
- B. Wood Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for historic treatment work, including protection of surrounding materials and Project site.
 - 1. If materials and methods other than those indicated are proposed for any phase of historic treatment work, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.

1.07 MOCKUPS

- A. Prepare mockups of historic treatment repair processes to demonstrate aesthetic effects, to set quality standards for materials and execution, and to set quality standards for fabrication and installation. Prepare mockups so they are inconspicuous.
 - 1. Locate mockups in locations that enable viewing under same conditions as the completed Work.

2. Wood Baseboard Repair: Prepare an approximately 72-inch length of baseboard to serve as mockup to demonstrate samples of each type of wood repair.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Pack, deliver, and store products in suitable packs, heavy-duty cartons, or wooden crates; surround with sufficient packing material to ensure that products will not be deformed, broken, or otherwise damaged.
- B. Until installed, store products inside a well-ventilated area and protect from weather, moisture, soiling, abrasion, extreme temperatures, and humidity, and where environmental conditions comply with manufacturer's requirements.

1.09 FIELD CONDITIONS

- A. Weather Limitations: Proceed with historic wood repair only when existing and forecasted weather conditions are within environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 PRODUCTS

2.01 HISTORIC WOOD REPAIR QUALITY STANDARD

- A. Quality Standard: Comply with applicable requirements in Section 12, "Historic Restoration Work," and related requirements in AWMAC/WI's "North American Architectural Woodwork Standards" for construction, finishes, grade rules, and other requirements unless otherwise indicated.
 1. Exception: Industry practices cited in Section 12, Paragraph 6, "Industry Practices," under Article 12.1, "Basic Considerations," of AWMAC/WI's "North American Architectural Woodwork Standards" do not apply to the Work of this Section.

2.02 REPLICATED WOOD ITEMS

- A. Replicated Wood Paneling and Trim: Custom-fabricated replacement wood units and components.
 1. Joint Construction: Joints matching existing joints.
 2. Wood Species: Match species of existing wood.
 3. Wood Cut: Match cut of existing wood.
 4. Wood Member and Trim Profiles: Match profiles and detail of existing.

2.03 WOOD-REPLACEMENT MATERIALS

- A. Wood, General: Clear fine-grained lumber; kiln dried to a moisture content of 6 to 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than 1/32 inch deep by 2 inches wide.
 1. Species: Match species of each existing type of wood component or assembly unless otherwise indicated.
- B. Paneling: Match existing species.
- C. Interior Trim: Match existing species.

2.04 WOOD-REPAIR MATERIALS

- A. Source Limitations: Obtain wood consolidant and wood-patching compound from single source from single manufacturer.
- B. Wood Consolidant: Ready-to-use product designed to penetrate, consolidate, and strengthen soft fibers of wood materials that have deteriorated due to weathering and decay and designed specifically to enhance the bond of wood-patching compound to existing wood.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. Abatron, Inc.
- C. Wood-Patching Compound: Two-part, epoxy-resin, wood-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of wood repair indicated, tooling time required for the detail of work, and site conditions. Compound must be designed for filling voids in damaged wood materials that have deteriorated due to weathering and decay. Compound must be capable of filling deep holes and spreading to featheredge.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Abatron, Inc.

2.05 MISCELLANEOUS MATERIALS

- A. Cleaning Materials:
 - 1. Detergent Solution: Solution prepared by mixing 2 cups of tetrasodium pyrophosphate (TSP), 1/2 cup of laundry detergent that contains no ammonia, 5 quarts of 5 percent sodium hypochlorite bleach, and 15 quarts of warm water for each 5 gal. of solution required.
 - 2. Mildewcide: Commercial, proprietary mildewcide or a solution prepared by mixing 1/3 cup of household detergent that contains no ammonia, 1 quart of 5 percent sodium hypochlorite bleach, and 3 quarts of warm water.
- B. Adhesives: Wood adhesives with minimum 15- to 45-minute cure at 70 deg F, in gunnable and liquid formulations as recommended in writing by adhesive manufacturer for each type of repair and exposure condition.
- C. Fasteners: Use fastener metals that are noncorrosive and compatible with each material joined.
 - 1. Match existing fasteners in material and type of fastener unless otherwise indicated.
 - 2. Use concealed fasteners for interconnecting wood components.
 - 3. Use concealed fasteners for attaching items to other work unless exposed fasteners are unavoidable or the existing fastening method.
 - 4. For fastening metals, use fasteners of same basic metal as fastened metal unless otherwise indicated.
 - 5. For exposed fasteners, use Phillips-type machine screws of head profile flush with metal surface unless otherwise indicated.
 - 6. Finish exposed fasteners to match finish of metal fastened unless otherwise indicated.

2.06 WOOD FINISHES

- A. Unfinished Replacement Units: Provide exposed interior wood surfaces of replacement units unfinished; smooth, filled, and suitably prepared for on-site priming and finishing.

PART 3 EXECUTION

3.01 PREPARATION

- A. Protect adjacent materials from damage by historic wood repair.
- B. Clean wood of mildew, algae, moss, plant material, loose paint, grease, dirt, and other debris by scrubbing with bristle brush or sponge and detergent solution. Scrub mildewed areas with mildewcide. After cleaning, rinse thoroughly with fresh water. Allow to dry before repairing or painting.
- C. Condition replacement wood members and replacement units to prevailing conditions at installation areas before installing.

3.02 HISTORIC WOOD REPAIR, GENERAL

- A. General: In treating historic items, disturb them as minimally as possible and as follows:
 - 1. Stabilize and repair wood to reestablish structural integrity and weather resistance while maintaining the existing form of each item.
 - 2. Remove coatings and apply borate preservative treatment before repair. Remove coatings in accordance with Section 090391 "Historic Treatment of Plain Painting" unless otherwise indicated.
 - 3. Repair items in place where possible.

4. Install temporary protective measures to protect wood-treatment work that is indicated to be completed later.
 5. Refinish historic wood in accordance with Section 090391 "Historic Treatment of Plain Painting" unless otherwise indicated.
- B. Mechanical Abrasion: Where mechanical abrasion is needed for the Work, use only the gentlest mechanical methods, such as scraping and natural-fiber bristle brushing, that will not abrade wood substrate, reducing clarity of detail. Do not use abrasive methods, such as sanding, wire brushing, or power tools, except as indicated as part of the historic treatment program and as approved by Architect.
- C. Repair Wood: Match existing materials and features, retaining as much original material as possible to perform repairs.
1. Unless otherwise indicated, repair wood by consolidating, patching, splicing, or otherwise reinforcing wood with new wood matching existing wood or with salvaged, sound, original wood.
 2. Where indicated, repair wood by limited replacement matching existing material.
- D. Replace Wood: Where indicated, duplicate and replace units with units made from salvaged, sound, original wood or with new wood matching existing wood. Use surviving prototypes to create patterns for duplicate replacements.
1. Do not use substitute materials unless otherwise indicated.
 2. Compatible substitute materials may be used.
- E. Identify removed items with numbering system corresponding to item locations, to ensure reinstallation in same location. Key items to Drawings showing location of each removed unit. Permanently label units in a location that will be concealed after reinstallation.

3.03 WOOD PATCH-TYPE REPAIR

- A. General: Patch wood that exhibits depressions, holes, or similar voids, and that has limited amounts of rotted or decayed wood.
1. Verify that surfaces are sufficiently clean and free of paint residue prior to patching.
 2. Treat wood with wood consolidant prior to application of patching compound. Coat wood surfaces by brushing, applying multiple coats until wood is saturated and refuses to absorb more. Allow treatment to harden before filling void with patching compound.
- B. Apply wood-patching compound to fill depressions, nicks, cracks, and other voids created by removed or missing wood.
1. Prime patch area with application of wood consolidant or manufacturer's recommended primer.
 2. Mix only as much patching compound as can be applied according to manufacturer's written instructions.
 3. Apply patching compound in layers as recommended in writing by manufacturer until the void is completely filled.
 4. Sand patch surface smooth and flush with adjacent wood, without voids in patch material, and matching contour of wood member.
 5. Clean spilled compound from adjacent materials immediately.

3.04 WOOD-REPLACEMENT REPAIR

- A. General: Replace parts of or entire wood items at locations indicated on Drawings.
1. Remove surface-attached items from wood surface before performing wood-replacement repairs unless otherwise indicated.
 2. Verify that surfaces are sufficiently clean and free of paint residue prior to repair.
 3. Remove broken, rotted, and decayed wood down to sound wood.
 4. Custom fabricate new wood to replace missing wood; either replace entire wood member or splice new wood part into existing member.
 5. Secure new wood using finger joints, multiple dowels, or splines with adhesive and nailing to ensure maximum structural integrity at each splice. Use only concealed fasteners. Fill nail holes and patch surface to match surrounding sound wood.

- B. Apply borate preservative treatment to accessible surfaces after replacements are made. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom.
- C. Repair remaining depressions, holes, or similar voids with patch-type repairs.
- D. Clean spilled materials from adjacent surfaces immediately.
- E. Reinstall items removed for repair into original locations.

3.05 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage wood-repair-material manufacturers' factory-authorized service representatives for consultation and Project-site inspection, and provide on-site assistance when requested by Architect.

3.06 ADJUSTMENT

- A. Adjust existing and replacement operating items, hardware, and accessories for a tight fit at contact points and for smooth operation and tight closure. Lubricate hardware and moving parts.

3.07 CLEANING AND PROTECTION

- A. Protect wood surfaces from contact with contaminating substances resulting from construction operations. Monitor wood surfaces adjacent to and below exterior concrete and masonry during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances contact wood surfaces, remove contaminants immediately.
- B. Clean exposed surfaces immediately after historic wood repair. Avoid damage to coatings and finishes. Remove excess sealants, patching materials, dirt, and other substances.

3.08 HISTORIC WOOD-REPAIR SCHEDULE

- A. Wall Paneling HWW-1: Rooms 134, 141, and 154 . Wainscot in Lecture Room, Boardroom, and Cafe.
 - 1. General: Remove paneling completely, store, and replace missing sections with new, replacement sections matching existing paneling.
 - 2. Maintain existing finish. Spot repair finish to match existing as needed.
 - 3. Stile-and-Rail Repairs (if needed): Wood consolidant, if feasible. Whole or partial member-replacement repairs if historic members are not salvageable using wood consolidant repair.
 - 4. Flat Panel Repairs (if needed): Wood consolidant, if feasible. Whole or partial member-replacement repairs if historic members are not salvageable using wood consolidant repair.
- B. Base Trim PB2: Wood base salvaged from rooms 116, 136, and 207.
 - 1. General: Remove trim completely, store, and replace missing sections with new, replacement sections matching existing paneling.
 - 2. Maintain existing finish. Spot repair finish to match existing as needed.
 - 3. Repairs (if needed): Wood consolidant, if feasible. Whole or partial member-replacement repairs if historic members are not salvageable using wood consolidant repair.
- C. Wood and Door Trim: Wood trim profiles WF1, WF2, WF3, WF4, and WF5 salvaged from windows and doors project wide.
 - 1. General: Remove trim completely, store, and replace missing sections with new, replacement sections matching existing paneling.
 - 2. Maintain existing finish. Spot repair finish to match existing as needed.
 - 3. Repairs (if needed): Wood consolidant, if feasible. Whole or partial member-replacement repairs if historic members are not salvageable using wood consolidant repair.
- D. Chair Rail PW1: Wood chair rail in Mezzanine 244.
 - 1. General: Remove trim completely, store, and replace missing sections with new, replacement sections matching existing paneling.
 - 2. Maintain existing finish. Spot repair finish to match existing as needed.

3. Repairs (if needed): Wood consolidant, if feasible. Whole or partial member-replacement repairs if historic members are not salvageable using wood consolidant repair.

END OF SECTION 060312

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**SECTION 061053
MISCELLANEOUS ROUGH CARPENTRY**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preservative treated wood materials.
- B. Fire retardant treated wood materials.
- C. Concealed wood blocking, nailers, and supports.
- D. Miscellaneous wood nailers, furring, and grounds.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.
- C. AWPA U1 - Use Category System: User Specification for Treated Wood 2022.
- D. PS 20 - American Softwood Lumber Standard 2021.
- E. WWPA G-5 - Western Lumber Grading Rules 2021.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. If no species is specified, provide species graded by the agency specified; if no grading agency is specified, provide lumber graded by grading agency meeting the specified requirements.
 - 2. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org) and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
 - 3. Lumber of other species or grades is acceptable provided structural and appearance characteristics are equivalent to or better than products specified.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Grading Agency: Western Wood Products Association; WWPA G-5.
- B. Sizes: Nominal sizes as indicated on drawings, S4S.
- C. Moisture Content: S-dry or MC19.
- D. Stud Framing for sizes 2 by 2 through 2 by 6 (50 by 50 mm through 50 by 150 mm):
 - 1. Species: Allowed under referenced grading rules.
 - 2. Grade: No.2.
- E. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
 - 1. Lumber: S4S, No.2 or Standard Grade.
 - 2. Boards: Standard or No.3.

2.03 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
 - 2. Anchors: Toggle bolt type for anchorage to hollow masonry.
- B. Die-Stamped Connectors: Hot dipped galvanized steel, sized to suit framing conditions.

2.04 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWWA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 - 1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
 - 2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWWA standards.
- B. Fire Retardant Treatment:
 - 1. Interior Type A: AWWA U1, Use Category UCFA, Commodity Specification H, low temperature, low hygroscopic type, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Treat rough carpentry items as indicated.
 - c. Do not use treated wood in applications exposed to weather or where the wood may become wet.
- C. Preservative Treatment:
 - 1. Preservative Pressure Treatment of Lumber Above Grade: AWWA U1, Use Category UC3B, Commodity Specification A using waterborne preservative to ____ lb/cu ft retention (to ____ kg/cu m retention).
 - a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 - b. Treat lumber in contact with masonry or concrete.

PART 3 EXECUTION

3.01 PREPARATION

3.02 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
- C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.03 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- B. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
- C. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.

3.04 CLEANING

- A. Waste Disposal: See Section 017419 - Construction Waste Management and Disposal.
 - 1. Comply with applicable regulations.
 - 2. Do not burn scrap on project site.
 - 3. Do not burn scraps that have been pressure treated.
 - 4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.
- B. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.

- C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION 061053

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SECTION 062000 FINISH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Finish carpentry items.
- B. Wood door frames, glazed frames.
- C. Wood casings and moldings.

1.02 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry: Support framing, grounds, and concealed blocking.
- B. Section 081433 - Stile and Rail Wood Doors.
- C. Section 099123 - Interior Painting: Painting of finish carpentry items.
- D. Section 099300 - Staining and Transparent Finishing: Staining and transparent finishing of finish carpentry items.

1.03 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition 2014, with Errata (2016).
- B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards 2021, with Errata.
- C. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood 2020.
- D. NHLA G-101 - Rules for the Measurement and Inspection of Hardwood and Cypress 2019.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with plumbing rough-in, electrical rough-in, installation of associated and adjacent components, and _____.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
- C. Samples: Submit two samples of wood trim ____ inch (____ mm) long.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store finish carpentry items under cover, elevated above grade, and in a dry, well-ventilated area not exposed to heat or sunlight.
- B. Protect from moisture damage.
- C. Handle materials and products to prevent damage to edges, ends, or surfaces.

PART 2 PRODUCTS

2.01 FINISH CARPENTRY ITEMS

- A. Interior Woodwork Items:
 - 1. Moldings, Bases, Casings, and Miscellaneous Trim: Finish as indicated in the drawings.

2.02 LUMBER MATERIALS

- A. Hardwood Lumber: Oak species, quarter sawn, maximum moisture content of 6 percent ; with vertical grain , of quality suitable for transparent finish.
 - 1. Grading: In accordance with NHLA G-101 Grading Rules; www.nhla.org.

2.03 SHEET MATERIALS

- A. Hardwood Plywood: Face species as indicated, plain sawn, book matched, medium density fiberboard core; HPVA HP-1 Front Face Grade AA, Back Face Grade 1, glue type as recommended for application.

2.04 FASTENINGS

- A. Adhesive for Purposes Other Than Laminate Installation: Suitable for the purpose; not containing formaldehyde or other volatile organic compounds.
- B. Fasteners: Of size and type to suit application; _____ finish in concealed locations and _____ finish in exposed locations.
- C. Concealed Joint Fasteners: Threaded steel.

2.05 ACCESSORIES

- A. Adhesive: Type recommended by fabricator to suit application.
- B. Lumber for Shimming, Blocking, and _____: Softwood lumber of _____ species.
- C. Wood Filler: Solvent base, tinted to match surface finish color.

2.06 FABRICATION

- A. Shop assemble work for delivery to site, permitting passage through building openings.
- B. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

2.07 SHOP FINISHING

- A. Apply wood filler in exposed nail and screw indentations.
- B. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:
 - 1. Transparent:
 - a. System - 1, Lacquer, Nitrocellulose.
 - b. Stain: Match existing.
 - c. Sheen: Flat.
 - 2. Opaque:
 - a. System - 1, Lacquer, Nitrocellulose.
 - b. Color: As selected by Architect.
 - c. Sheen: Flat.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing.

3.02 INSTALLATION

- A. Set and secure materials and components in place, plumb and level.
- B. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch (0.79 mm). Do not use additional overlay trim to conceal larger gaps.

3.03 SITE APPLIED WOOD TREATMENT

- A. Apply preservative treatment in accordance with manufacturer's instructions.
- B. Brush apply one coats of preservative treatment on wood in contact with cementitious materials. Treat site-sawn cuts.
- C. Allow preservative to dry prior to erecting members.

3.04 PREPARATION FOR SITE FINISHING

- A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth.

END OF SECTION 062000

**SECTION 071300
SHEET WATERPROOFING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Self-adhered modified bituminous sheet membrane.
- B. Blindsight HDPE reinforced sheet membrane.

1.02 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete substrate.

1.03 ABBREVIATIONS

- A. HDPE - High-Density Polyethylene.

1.04 REFERENCE STANDARDS

- A. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension 2016 (Reapproved 2021).
- B. ASTM D882 - Standard Test Method for Tensile Properties of Thin Plastic Sheeting 2018.
- C. ASTM D1876 - Standard Test Method for Peel Resistance of Adhesives (T-Peel Test) 2008, with Editorial Revision (2015).
- D. ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers 2022.
- E. ASTM D5295/D5295M - Standard Guide for Preparation of Concrete Surfaces for Adhered (Bonded) Membrane Waterproofing Systems 2018.
- F. ASTM D5385/D5385M - Standard Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes 2020.
- G. ASTM E154/E154M - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover 2008a (Reapproved 2019).
- H. NRCA (WM) - The NRCA Waterproofing Manual 2021.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for membrane.
- C. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.
- D. Certificate: Certify that products meet or exceed specified requirements.
- E. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention, and acceptable installation temperatures.
- F. Installer's qualification statement.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.07 MOCK-UPS

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Construct mock-up consisting of 100 sq ft (10 sq m) of horizontal sheet waterproofing panel; to represent finished work including internal and external corners, seam jointing, and attachment method.
- C. Locate where directed.
- D. Mock-up may remain as part of work.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperatures above 40 degrees F (5 degrees C) for 24 hours before and during application and until liquid or mastic accessories have cured.

1.09 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Contractor to correct defective Work within period of five years after Date of Substantial Completion; remove and replace materials concealing waterproofing at no extra cost to Owner.
- C. Provide five year manufacturer warranty for waterproofing failing to resist penetration of water, except where such failures are the result of structural failures of building. Hairline cracking of concrete due to temperature change or shrinkage is not considered a structural failure.

PART 2 PRODUCTS

2.01 SHEET WATERPROOFING APPLICATIONS

- A. Underslab HDPE Reinforced Sheet Membrane:
 - 1. Location: Under new basement slab on grade concrete.
- B. Modified Bituminous Sheet Membrane:
 - 1. Location: Exposed foundation walls.
 - 2. Vertical Surfaces: Adhesive bonded to substrate.
 - 3. Cover with protection board.

2.02 SHEET WATERPROOFING MATERIALS

- A. Self-Adhered Modified Bituminous Sheet Membrane:
 - 1. Thickness: 60 mil, 0.060 inch (1.5 mm), minimum.
 - 2. Sheet Width: 36 inches (0.914 m), minimum.
 - 3. Tensile Strength:
 - a. Film: 5,000 psi (34.57 MPa), minimum, measured in accordance with ASTM D882 and at grip-separation rate of 2 inches (50 mm) per minute.
 - b. Membrane: 325 psi (2.24 MPa), minimum, measured in accordance with ASTM D412 Method A, using die C and at spindle-separation rate of 2 inches (50 mm) per minute.
 - 4. Elongation at Break: 300 percent, minimum, measured in accordance with ASTM D412.
 - 5. Adhesion: 150 psi (1.03 MPa), minimum, measured in accordance with ASTM D4541.
 - 6. Hydrostatic Pressure Resistance: Membrane resists leakage for at least one hour from pressure equivalent to 200 feet (61 m) head of water applied in accordance with test method ASTM D5385/D5385M.
 - 7. Adhesives, Sealants, Tapes, and Accessories: As recommended by membrane manufacturer.
- B. Underslab HDPE Reinforced Sheet Membrane: Sheet membrane with cross-laminated, high-density HDPE backing laminated to waterproofing adhesive compound integrated into nonwoven geotextile fabric.
 - 1. Application: Install horizontally over prepared sub bases with concrete slab on grade.
 - 2. Sheet Thickness: 85 mil, 0.085 inch (2.16 mm), minimum.
 - 3. Puncture Resistance: 217 lb (98 kg), minimum, in accordance with ASTM E154/E154M.
 - 4. Adhesion: 150 psi (1.03 MPa), minimum, measured in accordance with ASTM D4541.
 - 5. Products:
 - a. Polyguard Products, Inc; Underseal Underslab Membrane: www.polyguardproducts.com/#sle.
 - b. GCP Preprufe 300R.
 - c. Sika SikaProof 808.
 - d. Substitutions: See Section 016000 - Product Requirements.
- C. Modified Bituminous Sheet Membrane: Asphalt and polymer modifiers of SBS type, reinforced with nonwoven glass fibers; smooth surfaced.
 - 1. Formulated for seaming by heat welding.

2. Thickness: 100 mil, 0.10 inch (2.5 mm), minimum.
3. Sheet Width: 19-11/16 inches (0.5 m), minimum.

2.03 ACCESSORIES

- A. Seaming Materials: As recommended by membrane manufacturer.
- B. Membrane Sealant: As recommended by membrane manufacturer.
- C. Sealant for Cracks and Joints In Substrates: Resilient elastomeric joint sealant compatible with substrates and waterproofing materials.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions are acceptable prior to starting work.
- B. Verify substrate surfaces are durable; free of matter detrimental to adhesion or application of waterproofing system.
- C. Verify that items penetrating surfaces to receive waterproofing are securely installed.
- D. Where existing conditions are responsibility of another installer, notify Architect of unsatisfactory conditions.
- E. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protect adjacent surfaces from damage not designated to receive waterproofing.
- B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions; vacuum substrate clean, power wash and scrub as needed
- C. Do not apply waterproofing to surfaces unacceptable to membrane manufacturer.
- D. Surfaces for Adhesive Bonding: Apply surface conditioner at a rate recommended by manufacturer, and protect conditioner from rain or frost until dry.
- E. Concrete Surfaces for Adhesive Bonding: Prepare concrete substrate in accordance with ASTM D5295/D5295M.
 1. Remove substances that inhibit adhesion including form release agents, curing compounds admixtures, laitance, moisture, dust, dirt, grease and oil.
 2. Repair surface defects including honeycombs, fins, tie holes, bug holes, sharp offsets, rutted cracks, ragged corners, deviations in surface plane, spalling and delaminations, as described in reference standard.
 3. Remove and replace areas of defective concrete; see Section 033000.
 4. Prepare concrete for adhesive bonded waterproofing using mechanical or chemical methods described in referenced standard.
 5. Test concrete surfaces as described in referenced standards, and verify surfaces are ready to receive adhesive bonded waterproofing membrane system.

3.03 INSTALLATION - MEMBRANE

- A. Install membrane waterproofing in accordance with manufacturer's instructions and NRCA (WM) applicable requirements.
- B. Roll out membrane, and minimize wrinkles and bubbles.
- C. Self-Adhering Membrane: Remove release paper layer, and roll out onto substrate with a mechanical roller to provide full contact bond.
- D. Overlap edges and ends, minimum 3 inches (76 mm), seal permanently waterproof by method recommended by manufacturer, and apply uniform bead of sealant to joint edge.
- E. Reinforce membrane with multiple thickness of membrane material over joints, whether joints are static or dynamic.
- F. Weather lap joints on sloped substrate in direction of drainage, and seal joints and seams.

- G. Flexible Flashings: Seal items watertight that penetrate through waterproofing membrane with flexible flashings.
- H. Seal membrane and flashings to adjoining surfaces.

3.04 PROTECTION

- A. Do not permit traffic over unprotected or uncovered membrane.

END OF SECTION 071300

**SECTION 072119
FOAMED-IN-PLACE INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Foamed-in-place insulation.
 - 1. In exterior framed walls.
- B. Foamed-in-place intumescent insulation, single-layer monolithic system.

1.02 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- B. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics 2016.
- C. ASTM D1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics 2020.
- D. ASTM D1623 - Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics 2017.
- E. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics 2019.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.
- G. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022.
- H. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials 2021a.
- I. FM 4880 - Evaluating the Fire Performance of Insulated Building Panel Assemblies and Interior Finish Materials 2017.
- J. NFPA 275 - Standard Method of Fire Tests for the Evaluation of Thermal Barriers 2022.
- K. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components 2019.
- L. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth 2019.
- M. UL 1040 - Standard for Safety Fire Test of Insulated Wall Construction Current Edition, Including All Revisions.
- N. UL 1715 - Standard for Safety Fire Test of Interior Finish Material Current Edition, Including All Revisions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Foamed-In-Place Insulation:
 - 1. BASF Corporation; WALLTITE US Series Closed Cell: www.spf.basf.com/#sle.
 - 2. Carlisle Spray Foam Insulation; _____: www.carlisesfi.com/#sle.
 - 3. Henry Company; _____: www.henry.com/#sle.
 - 4. Huntsman Building Solutions; Heatlok HFO Pro: www.huntsmanbuildingsolutions.com/#sle.
 - 5. Johns Manville; JM Corbond III Closed Cell Spray Polyurethane Foam: www.jm.com/#sle.
 - 6. Substitutions: See Section 016000 - Product Requirements.

2.02 MATERIALS

- A. Foamed-In-Place Intumescent Insulation (Single-Layer Monolithic System): Medium-density, rigid, two-part, closed cell polyurethane foam; foamed on-site using blowing agent of non-ozone-depleting gas.

1. Regulatory Requirements: Comply with applicable code for flame and smoke, concealment, and fire protection requirements.
2. Regulatory Requirements: Comply with applicable code for flame and smoke, concealment, and fire protection requirements.
 - a. Fire Protection: Provide 15-minute thermal barrier of 1/2 inch (12.7 mm) gypsum board or equivalent material complying with NFPA 275 test method, or foamed-in-place insulation either exposed or with covering that complies with FM 4880, NFPA 286, UL 1040, or UL 1715.
3. Thermal Resistance: R-value (RSI-value) of 5.7 (1.0), minimum, per 1 inch (25.4 mm) thickness at 140 degrees F (60 degrees C) mean temperature, at 90 days, when tested in accordance with ASTM C518.
4. Water Vapor Permeance: 0.99 perms (56.64 ng/(Pa s sq m)), maximum, when tested at 3.5 inch (89 mm) thickness in accordance with ASTM E96/E96M.
5. Air Permeance: 0.002 cfm per sq ft (0.011 L/(s/sq m)), maximum, when tested at 1 inch (25.4 mm) thickness in accordance with ASTM E2178 at 1.57 psf (75 Pa).
6. Closed Cell Content: At least 90 percent.
7. Density: 2.0 lbs/cu ft (32 kg/cu m), nominal, in accordance with ASTM D1622.
8. Tensile Strength: 55 psi (379 kPa), minimum, in accordance with ASTM D1623.
9. Compressive Strength: 22 psi (152 kPa), minimum, in accordance with ASTM D1621.
10. Surface Burning Characteristics: Flame spread/smoke developed index of 25/450, maximum, at 4 inch (102 mm) thick when tested in accordance with ASTM E84.

2.03 ACCESSORIES

- A. Primer: As required by insulation manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify work within construction spaces or crevices is complete prior to insulation application.
- B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation or overcoat adhesion.

3.02 PREPARATION

- A. Mask and protect adjacent surfaces from over spray or dusting.
- B. Apply primer in accordance with manufacturer's instructions.

3.03 APPLICATION

- A. Apply insulation in accordance with manufacturer's instructions.
- B. Apply to achieve a thermal resistance R-value of 30 (RSI-value of 5.2830).

3.04 PROTECTION

- A. Do not permit subsequent construction work to disturb applied insulation.

END OF SECTION 072119

SECTION 076200
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fabricated sheet metal items, including flashings, counterflashings, gutters, downspouts, sheet metal roofing, exterior penetrations, _____, and other items indicated in Schedule.
- B. Sealants for joints within sheet metal fabrications.

1.02 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix) 2020, with Errata (2022).
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- C. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2021a.
- D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants 2018.
- E. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free 2007 (Reapproved 2018).
- F. CDA A4050 - Copper in Architecture - Handbook current edition.
- G. SMACNA (ASMM) - Architectural Sheet Metal Manual 2012.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- B. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Sheet Metal Flashing and Trim:

2.02 SHEET MATERIALS

- A. Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch (0.61 mm) thick base metal.
- B. Pre-Finished Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch (0.61 mm) thick base metal, shop pre-coated with PVDF coating.
 - 1. Polyvinylidene Fluoride (PVDF) Coating: Superior performing organic powder coating, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system.
- C. Anodized Aluminum: ASTM B209/B209M, 3005 alloy, H12 or H14 temper; 20 gauge, 0.032 inch (0.81 mm) thick; clear anodized finish.

2.03 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.

- B. Form pieces in longest possible lengths.
- C. Hem exposed edges on underside 1/2 inch (13 mm); miter and seam corners.
- D. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- E. Fabricate corners from one piece with minimum 18-inch (450 mm) long legs; seam for rigidity, seal with sealant.
- F. Fabricate vertical faces with bottom edge formed outward 1/4 inch (6 mm) and hemmed to form drip.
- G. Fabricate flashings to allow toe to extend 2 inches (50 mm) over roofing gravel. Return and brake edges.

2.04 ACCESSORIES

- A. Fasteners: Galvanized steel, with soft neoprene washers.
- B. Primer Type: Zinc chromate.
- C. Concealed Sealants: Non-curing butyl sealant.
- D. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.
- E. Asphalt Roof Cement: ASTM D4586/D4586M, Type I, asbestos-free.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

- A. Install starter and edge strips, and cleats before starting installation.
- B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil, 0.015 inch (0.38 mm).

3.03 INSTALLATION

- A. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted..
- B. Apply plastic cement compound between metal flashings and felt flashings.
- C. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for field inspection requirements.
- B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

END OF SECTION 076200

SECTION 078400 FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Firestopping systems.
- B. Firestopping of joints and penetrations in fire-resistance-rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.02 RELATED REQUIREMENTS

- A. Section 092116 - Gypsum Board Assemblies: Gypsum wallboard fireproofing.

1.03 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials 2020.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).
- C. ITS (DIR) - Directory of Listed Products Current Edition.
- D. FM (AG) - FM Approval Guide current edition.
- E. UL 1479 - Standard for Fire Tests of Penetration Firestops Current Edition, Including All Revisions.
- F. UL (FRD) - Fire Resistance Directory Current Edition.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
- C. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.

1.05 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
 - 1. Listing in UL (FRD), FM (AG), or ITS (DIR) will be considered as constituting an acceptable test report.
 - 2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
 - 3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Firestopping Manufacturers:
 - 1. 3M Fire Protection Products; _____: www.3m.com/firestop/#sle.
 - 2. A/D Fire Protection Systems Inc; _____: www.adfire.com/#sle.
 - 3. Rectorseal, a CSW Industrials Company; Metacaulk 150+ General Purpose Firestop Sealant: www.metacaulk.com/#sle.
 - 4. Everkem Diversified Products, Inc; Intumescent Fire-Rated Putty Pads: www.everkemproducts.com/#sle.
 - 5. Grabber Construction Products, Inc; GrabberGard EFC: www.grabberman.com/#sle.
 - 6. Hilti, Inc; _____: www.hilti.com/#sle.
 - 7. HoldRite, a Brand of Reliance Worldwide Corporation; HydroFlame 100 Intumescent Firestop Sealant: www.holdrite.com/#sle.
 - 8. MarinoWARE; _____: www.marinoware.com/#sle.
 - 9. Nelson FireStop Products; _____: www.nelsonfirestop.com/#sle.

10. Passive Fire Protection Partners; Firestop 3600EX: www.firestop.com/#sle.
11. Specified Technologies Inc; _____: www.stifirestop.com/#sle.
12. Tremco Commercial Sealants & Waterproofing; TREMstop Acrylic:
www.tremcosealants.com/#sle.

2.02 MATERIALS

- A. Firestopping Materials: Any materials meeting requirements.
- B. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.

2.03 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

2.04 FIRESTOPPING PENETRATIONS THROUGH CONCRETE AND CONCRETE MASONRY CONSTRUCTION

2.05 FIRESTOPPING PENETRATIONS THROUGH FRAMED FLOORS

- A. Metallic Pipe, Conduit, and Tubing Penetrations in Framed Floors:
 1. 1 and 2 Hour Construction: UL System F-C-1177; HoldRite HydroFlame 200 Intumescent Firestop Sealant.
 2. 1 Hour Construction: UL System F-C-1053; Specified Technologies Inc. WF300 Intumescent Firestop Caulk (For Wood Frame Construction).
 3. 1 Hour Construction: UL System F-C-1162; Specified Technologies Inc. Closet Flange Firestop Gasket.

2.06 FIRESTOPPING PENETRATIONS THROUGH GYPSUM BOARD WALLS

- A. Blank Openings:
 1. 1 Hour Construction: UL System W-L-0020; Specified Technologies Inc. Composite Sheet.

2.07 FIRESTOPPING SYSTEMS

- A. Firestopping: Any material meeting requirements.
 1. Fire Ratings: Use system that is listed by FM (AG), ITS (DIR), or UL (FRD) and tested in accordance with ASTM E814, ASTM E119, or UL 1479 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.
 2. Fire Ratings: See drawings for required systems and ratings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.

3.03 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

3.04 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.05 PROTECTION

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 078400

SECTION 079200 JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nonsag gunnable joint sealants.

1.02 RELATED REQUIREMENTS

- A. Section 092116 - Gypsum Board Assemblies: Sealing acoustical and sound-rated walls and ceilings.

1.03 REFERENCE STANDARDS

- A. ASTM C920 - Standard Specification for Elastomeric Joint Sealants 2018.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's technical datasheets for each product to be used; include the following:
 - 1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.
 - 3. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 - 4. Substrates the product should not be used on.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Nonsag Sealants:
 - 1. Henry Company; _____: www.henry.com/#sle.
 - 2. Sherwin-Williams Company; _____: www.sherwin-williams.com/#sle.
 - 3. Sika Corporation; _____: www.usa.sika.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.

2.02 JOINT SEALANT APPLICATIONS

- A. Scope:
 - 1. Interior Joints: Do not seal interior joints unless specifically indicated to be sealed. Interior joints to be sealed include, but are not limited to, the following items.
 - a. Joints between door, window, and other frames and adjacent construction.
 - b. Other joints indicated below.
- B. Type ___ - Interior Joints: Use nonsag polyurethane sealant, unless otherwise indicated.

2.03 JOINT SEALANTS - GENERAL

2.04 NONSAG JOINT SEALANTS

- A. Type ___ - Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.
 - 1. Movement Capability: Plus and minus _____ percent, minimum.

END OF SECTION 079200

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SECTION 080314 HISTORIC TREATMENT OF WOOD DOORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Historic treatment of wood doors in the form of the following:
 - a. Repairing wood doors and trim.
 - b. Reglazing.
- B. Related Requirements:
 - 1. Section 013591 "Historic Treatment Procedures" for general historic treatment requirements.
 - 2. Section 024296 "Historic Removal and Dismantling" for historic removal and dismantling work.
 - 3. Section 060312 "Historic Wood Repair" for historic wood repair work.

1.02 DEFINITIONS

- A. Door: Generally, this term includes door frame, leaves, hardware, side panels or lights, fan light, transom, storm and screen doors, and storm vestibule unless otherwise indicated by context.
- B. Glazing: Includes glass, glazing points, glazing tapes, glazing sealants, and glazing compounds.
- C. Storm Vestibule: Removable winter enclosure erected on a covered porch, which includes side panels or lights and door leaf and may include top panels.
- D. Wood Door Component Terminology: Wood door components for historic treatment work include the following classifications:
 - 1. Frame Components: Head, jambs, stop, and threshold or sill.
 - 2. Leaf Components: Stiles, rails, and muntins.
 - 3. Exterior Trim: Exterior casing, brick mold, and cornice or drip cap.
 - 4. Interior Trim: Casing.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to historic treatment of wood doors including, but not limited to, the following:
 - a. Historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.
 - c. Fire-protection plan.
 - d. Wood door historic treatment program.

1.04 SEQUENCING AND SCHEDULING

- A. The intent of historic wood door refinishing is to have a light touch, maintaining their historic look while bringing them to a "like new" condition.
- B. Perform historic treatment of wood doors in the following sequence, which includes Work specified in this and other Sections:
 - 1. Label each door frame with permanent opening-identification number in inconspicuous location.
 - 2. Tag existing door leaves, storm doors, storm-vestibule panels, and screen doors with opening-identification numbers and remove for on-site or off-site repair. Indicate on tags the locations of each component, such as "left-hand door leaf," "right-hand reverse door leaf," "top dutch-door leaf," "bottom dutch-door leaf," "first left-side storm-vestibule panel," and "second left-side storm-vestibule panel."
 - 3. Remove door, dismantle hardware, and tag hardware with door opening-identification numbers.

4. In the shop, label each leaf, storm door, storm-vestibule panel, and screen door with permanent opening-identification number in inconspicuous location and remove site-applied tags.
5. Install temporary protection and security at door openings.
6. Sort units by condition, separating those that need extensive repair. Inform Architect of any units that need extensive repair
7. Clean surfaces.
8. General Wood-Repair Sequence:
 - a. Light sanding. Do not sand through existing finish if it still exists.
 - b. Repair deep gouges and any nail holes with wood filler.
 - c. Rack loose frames slightly to inject adhesive into mortise and tenon joints; square frames to proper fit before adhesive sets.
 - d. Replace broken glass with tempered safety glazing.
 - e. For extensive decay or damage:
 - 1) Repair decayed wood by consolidation, member replacement, partial member replacement, and patching.
 - 2) Sand, fill, sand again, and prep surfaces again for refinishing.
9. Repair, refinish, and replace hardware as noted. Reinstall operating hardware. Alert Architect of any hardware that is non-functional for evaluation and repair direction.
10. Install glazing.
11. Reinstall units.
12. Apply 2 clear finish coats.
13. Install remaining hardware and weather stripping.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include recommendations for product application and use. Include test data substantiating that products comply with requirements.
- B. Shop Drawings: For locations and extent of wood-door repair and replacement work.
 1. Include plans, elevations, sections, and details of replacement parts indicating materials, profiles, joinery, reinforcing, method of splicing into or attaching to existing wood door, accessory items, and finishes.
 2. Include field-verified dimensions and the following:
 - a. Full-size shapes and profiles with complete dimensions for replacement components and their jointing, showing relation of existing to new components.
 - b. Templates and directions for installing hardware and anchorages.
 - c. Identification of each new unit and its corresponding door locations in the building on annotated plans and elevations.
- C. Samples for Initial Selection: For each type of exposed wood and finish.
 1. Identify wood species, cut, and other features.
 2. Include Samples of hardware and accessories involving color selection.
- D. Samples for Verification: Actual sample of finished products for the following, in manufacturer's standard sizes unless otherwise indicated:
 1. Replacement Units: 12-inch-long, full-size frame, leaf, and interior trim sections with applied finish.
 2. Replacement Members: 12 inches long for each replacement member, including parts of frame, leaf, exterior trim, and interior trim.
 - a. Additional Samples of replacement members that show fabrication techniques, materials, and finishes as requested by Architect.
 3. Repaired Wood Door Members: Prepare Samples using existing wood door members removed from site, repaired, and prepared for refinishing.
 4. Refinished Wood Door Members: Prepare Samples using existing wood door members removed from site, repaired, and refinished.
 5. Hardware: Full-size units with each factory-applied or restored finish.
 6. Weather Stripping: 12-inch-long sections.

7. Glass: 9-inch by 9-inch minimum units of each type and appearance.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Statements: For historic treatment specialist.
- B. Wood Door Historic Treatment Program: Submit before work begins.

1.07 QUALITY ASSURANCE

- A. Historic Treatment Specialist Qualifications: A qualified historic wood door specialist, experienced in repairing, refinishing, and replacing wood doors in whole and in part. Experience only in fabricating and installing new wood doors is insufficient experience for wood-door historic treatment work.
- B. Wood Door Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for historic treatment work, including protection of surrounding materials and Project site.
 1. If materials and methods other than those indicated are proposed for any phase of historic treatment work, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.

1.08 MOCKUPS

- A. Prepare mockups of historic treatment repair processes to demonstrate aesthetic effects, to set quality standards for materials and execution, and to set quality standards for fabrication and installation. Prepare mockups so they are inconspicuous.
 1. Locate mockups in locations that enable viewing under same conditions as the completed Work.
 2. Wood Door Repair: Prepare one entire door unit to serve as mockup to demonstrate Samples of each type of repair of wood door members including frame, leaves, trim, glazing, and hardware.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Pack, deliver, and store products in suitable packs, heavy-duty cartons, or wooden crates; surround with sufficient packing material to ensure that products will not be deformed, broken, or otherwise damaged.
- B. Store products inside a well-ventilated area, protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity, and where environmental conditions comply with manufacturer's requirements.

1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with historic treatment of wood doors only when existing and forecasted weather conditions are within environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 PRODUCTS

2.01 HISTORIC TREATMENT OF WOOD DOORS QUALITY STANDARD

- A. Quality Standard: Comply with applicable requirements in Section 12, "Historic Restoration Work," and related requirements in AWMAC/WI's "North American Architectural Woodwork Standards" for construction, finishes, grades of wood doors, and other requirements unless otherwise indicated.
 1. Exception: Industry practices cited in Section 12, Paragraph 6, "Industry Practices," under Article 12.1, "Basic Considerations," of AWMAC/WI's "North American Architectural Woodwork Standards" do not apply to the Work of this Section.

2.02 REPLACEMENT WOOD DOOR UNITS

- A. Replacement Wood Door Units: Custom-fabricated, replicated wood door units and trim with operating and latching hardware.
 - 1. Wood Door Components: Replace frames, leaves, and trim.
 - 2. Joint Construction: Joints matching existing.
 - 3. Wood Species: Match wood species of existing door components.
 - 4. Wood Cut: Match cut of existing wood door components.
 - 5. Wood Member and Trim Profiles: Match profiles and detail of existing door members and trim.
 - 6. Hardware: Reuse existing unless otherwise indicated.
 - 7. Hardware Set: Door Hardware Set No. in accordance with Section 087100 "Door Hardware."
 - 8. Glazing Stops: Provide replacement glazing stops coordinated with glazing system indicated.
 - 9. Weather Stripping: Full-perimeter weather stripping for each exterior door leaf.

2.03 WOOD-REPLACEMENT MATERIALS

- A. Wood, General: Clear fine-grained lumber; kiln dried to a moisture content of 6 to 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than 1/32 inch deep by 2 inches wide.
 - 1. Species: Match species of each existing type of wood component or assembly unless otherwise indicated.
- B. Frame Heads and Jambs: Match existing species.
- C. Leaf Components: Match existing species.
- D. Interior Trim: Match existing species.

2.04 WOOD-REPAIR MATERIALS

- A. Source Limitations: Obtain wood consolidant and wood-patching compound from single source from single manufacturer.
- B. Wood Consolidant: Ready-to-use product designed to penetrate, consolidate, and strengthen soft fibers of wood materials that have deteriorated because of weathering and decay and designed specifically to enhance the bond of wood-patching compound to existing wood.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Abatron, Inc.
- C. Wood-Patching Compound: Two-part, epoxy-resin, wood-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of wood repair indicated, tooling time required for the detail of work, and site conditions. Compound to be designed for filling voids in damaged wood materials that have deteriorated because of weathering and decay. Compound to be capable of filling deep holes and spreading to feather edge.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Abatron, Inc.

2.05 GLAZING MATERIALS

- A. Glass:
 - 1. See Section 088000 "Glazing."
- B. Glazing Systems:
 - 1. Traditional Glazing Products: Glazing points and oil-based glazing putty or latex glazing compound. Tint to required color in accordance with manufacturer's written instructions.
 - 2. Primers and Cleaners for Glazing: As recommended in writing by glazing material manufacturer.

2.06 HARDWARE

- A. Primary Door Hardware, General: Leave door hardware on existing doors, as indicated on door schedule.
- B. Hardware Finishes: Comply with BHMA A156.18 for base material and finish requirements indicated by the following:
 - 1. BHMA 605: Bright brass, clear coated; brass base metal.
 - 2. BHMA 606: Satin brass, clear coated; brass base metal.
 - 3. BHMA 611: Bright bronze, clear coated; bronze base metal.
 - 4. BHMA 612: Satin bronze, clear coated; bronze base metal.
 - 5. BHMA 613: Dark-oxidized satin bronze, oil rubbed; bronze base metal.
 - 6. BHMA 624: Dark-oxidized statuary bronze, clear coated; bronze base metal.
 - 7. BHMA 628: Satin aluminum, clear anodized; aluminum base metal.
 - 8. BHMA 630: Satin stainless steel; stainless steel base metal.
 - 9. BHMA 689: Aluminum painted; over any base metal.

2.07 MISCELLANEOUS MATERIALS

- A. Cleaning Materials:
 - 1. Detergent Solution: Solution prepared by mixing 2 cups of tetrasodium pyrophosphate, 1/2 cup of laundry detergent that contains no ammonia, 5 quarts of 5 percent sodium hypochlorite bleach, and 15 quarts of warm water for each 5 gal. of solution required.
 - 2. Mildewcide: Commercial, proprietary mildewcide or a solution prepared by mixing 1/3 cup of household detergent that contains no ammonia, 1 quart of 5 percent sodium hypochlorite bleach, and 3 quarts of warm water.
- B. Adhesives: Wood adhesives with minimum 15- to 45-minute cure at 70 deg F, in gunnable and liquid formulations as recommended in writing by adhesive manufacturer for each type of repair and exposure conditions.
- C. Fasteners: Use fastener metals that are noncorrosive and compatible with each material joined.
 - 1. Match existing fasteners in material and type of fastener unless otherwise indicated.
 - 2. Use concealed fasteners for interconnecting wood components.
 - 3. Use concealed fasteners for attaching items to other work unless exposed fasteners are unavoidable or the existing fastening method.
 - 4. For fastening metals, use fasteners of same basic metal as fastened metal unless otherwise indicated.
 - 5. Finish exposed fasteners to match finish of metal fastened unless otherwise indicated.
- D. Anchors, Clips, and Accessories: Fabricate anchors, clips, and door accessories of aluminum, nonmagnetic stainless steel, or hot-dip zinc-coated steel complying with requirements in ASTM B633 for SC 3 (Severe) service condition.

2.08 WOOD DOOR FINISHES

- A. Unfinished Replacement Units: Provide exposed interior wood surfaces of replacement units unfinished; smooth, filled, and suitably prepared for on-site priming and finishing.

PART 3 EXECUTION

3.01 PREPARATION

- A. Protect adjacent materials from damage by historic treatment of wood doors.
- B. Clean wood doors and trim of mildew, algae, moss, plant material, loose paint, grease, dirt, and other debris by scrubbing with bristle brush or sponge and detergent solution. Scrub mildewed areas with mildewcide. After cleaning, rinse thoroughly with fresh water. Allow to dry before repairing or painting.
- C. Condition replacement wood members and replacement units to prevailing conditions at installation areas before installing.

3.02 HISTORIC TREATMENT OF WOOD DOORS, GENERAL

- A. Historic Treatment Appearance Standard: Completed work is to have a uniform appearance as viewed by Architect from the door interior at 5 ft. away and from the door exterior at 20 ft. away.
- B. General: In treating historic items, disturb them as minimally as possible and as follows:
 - 1. Stabilize and repair wood doors to reestablish structural integrity and weather resistance while maintaining the existing form of each item.
 - 2. Repair items in place where possible.
 - 3. Install temporary protective measures to protect wood door work that is indicated to be completed later.
- C. Mechanical Abrasion: Where mechanical abrasion is needed for the Work, use only the gentlest mechanical methods, such as scraping and natural-fiber bristle brushing, that will not abrade wood substrate, reducing clarity of detail. Do not use abrasive methods such as sanding, wire brushing, or power tools except as indicated as part of the historic treatment program and as approved by Architect.
- D. Repair Wood Doors: Match existing materials and features, retaining as much original material as possible to perform repairs.
 - 1. Unless otherwise indicated, repair wood doors by consolidating, patching, splicing, or otherwise reinforcing wood with new wood matching existing wood or with salvaged, sound, original wood.
 - 2. Where indicated, repair wood doors by limited replacement matching existing material.
- E. Replace Wood Units: Where indicated, duplicate and replace units with units made from salvaged, sound, original wood or with new wood matching existing wood. Use surviving prototypes to create patterns for duplicate replacements.
 - 1. Do not use substitute materials unless otherwise indicated.
 - 2. Compatible substitute materials may be used.
- F. Protection of Openings: Where doors are indicated for removal, cover resultant openings with temporary enclosures so that openings are weathertight during repair period.
- G. Identify removed doors, frames, leaves, trim, and members with numbering system corresponding to door locations to ensure reinstallation in same location. Key doors, frames, leaves, trim, and members to Drawings showing location of each removed unit. Permanently label units in a location that will be concealed after reinstallation.

3.03 WOOD DOOR PATCH-TYPE REPAIR

- A. General: Patch wood members that exhibit depressions, holes, or similar voids and that have limited amounts of rotted or decayed wood.
 - 1. Remove leaves from door frames before performing patch-type repairs at meeting or sliding surfaces unless otherwise indicated. Reglaze units prior to reinstallation.
 - 2. Verify that surfaces are sufficiently clean and free of paint residue before patching.
 - 3. Treat wood members with wood consolidant before applying patching compound. Coat wood surfaces by brushing, applying multiple coats until wood is saturated and unable to absorb more. Allow treatment to harden before filling void with patching compound.
 - 4. Remove rotted or decayed wood down to sound wood.
- B. Apply borate preservative treatment to accessible surfaces either before applying wood consolidant or after removing rotted or decayed wood. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom. Allow treatment to dry.
- C. Apply wood-patching compound to fill depressions, nicks, cracks, and other voids created by removed or missing wood.
 - 1. Prime patch area with application of wood consolidant or manufacturer's recommended primer.
 - 2. Mix only as much patching compound as can be applied in accordance with manufacturer's written instructions.
 - 3. Apply patching compound in layers as recommended in writing by manufacturer until the void is completely filled.

4. Sand patch surface smooth and flush with adjacent wood, without voids in patch material, and matching contour of wood member.
5. Clean spilled compound from adjacent materials immediately.

3.04 WOOD DOOR MEMBER-REPLACEMENT REPAIR

- A. General: Replace parts of or entire wood door members at locations indicated on Drawings and where damage is too extensive to patch.
 1. Remove leaves from door frames before performing member-replacement repairs unless otherwise indicated.
 2. Verify that surfaces are sufficiently clean and free of paint residue before repair.
 3. Remove broken, rotted, and decayed wood down to sound wood.
 4. Custom fabricate new wood to replace missing wood; either replace entire wood member or splice new wood part into existing member.
 5. Secure new wood using finger joints, multiple dowels, or splines with adhesive and nailing to ensure maximum structural integrity at each splice. Use only concealed fasteners. Fill nail holes and patch surface to match surrounding sound wood.
- B. Apply borate preservative treatment to accessible surfaces after replacements are made. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom.
- C. Repair remaining depressions, holes, or similar voids with patch-type repairs.
- D. Clean spilled materials from adjacent surfaces immediately.
- E. Glazing: Reglaze units before reinstallation.
 1. Mill new and rout existing glazed members to accommodate new glass thickness.
 2. Provide replacement glazing stops coordinated with glazing system indicated.
 3. Provide glazing stops to match contour of door frames.
- F. Reinstall units removed for repair into original openings.
- G. Weather Stripping: Replace nonfunctioning and install missing weather stripping to ensure full-perimeter weather stripping for each exterior leaf.

3.05 GLAZING

- A. Comply with combined written instructions of glass, glazing system, and glazing material manufacturers, unless more stringent requirements are indicated.
- B. Remove cracked and damaged glass and glazing materials from openings and prepare surfaces for reglazing.
- C. Remove existing glass and glazing where indicated on Drawings, and prepare surfaces for reglazing.
- D. Remove glass and glazing from openings and prepare surfaces for reglazing.
- E. Size glass as required by Project conditions to provide necessary bite on glass, minimum edge and face clearances, with reasonable tolerances.
- F. Apply primers to joint surfaces where required for adhesion of glazing system, as determined by preconstruction testing.
- G. Install setting bead, side beads, and back bead against stop in glazing rabbets before setting glass.
- H. Install glass with proper orientation so that coatings, if any, face exterior or interior as required.
- I. Install glazing points.
- J. Disposal of Removed Glass: Protect unbroken lites and deliver as salvage to Owner for storage where directed unless otherwise indicated.

3.06 WOOD DOOR UNIT REPLACEMENT

- A. General: Replace existing wood door-frame leaf trim units with new custom-fabricated replicated units at locations indicated on Drawings.

- B. Apply borate preservative treatment to accessible surfaces before finishing. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom.
- C. Mill glazed members to accommodate glass thickness. Glaze units before installation.
- D. Install units, hardware, weather stripping, accessories, and other components as indicated on Drawings.
- E. Install units level, plumb, square, true to line, without distortion or impeding movement, anchored securely in place to structural support, and in proper relation to wall flashing, trim, and other adjacent construction.
- F. Set threshold or sill members in bed of sealant for weathertight construction unless otherwise indicated.
- G. Install door units with new anchors into existing openings.
- H. Install full-perimeter weather stripping for each operable exterior leaf.
- I. Metal Protection: Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.
- J. Disposal of Removed Units: Remove from Owner's property and legally dispose of them.

3.07 INSTALLATION OF WEATHER STRIPPING

- A. Install weather stripping for tight seal of joints as determined by preconstruction testing and demonstrated in mockup.

3.08 ADJUSTING

- A. Adjust existing and replacement operating leaves, screens, hardware, weather stripping, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.

3.09 CLEANING AND PROTECTION

- A. Protect door surfaces from contact with contaminating substances resulting from construction operations. Monitor door surfaces adjacent to and below exterior concrete and masonry during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances contact door surfaces, remove contaminants immediately.
- B. Clean exposed surfaces immediately after historic treatment of wood doors. Avoid damage to coatings and finishes. Remove excess sealants, glazing and patching materials, dirt, and other substances.
- C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

END OF SECTION 080314

**SECTION 081113
HOLLOW METAL DOORS AND FRAMES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Non-fire-rated hollow metal doors and frames.

1.02 RELATED REQUIREMENTS

- A. Section 087100 - Door Hardware.
- B. Section 099123 - Interior Painting: Field painting.

1.03 ABBREVIATIONS AND ACRONYMS

- A. ANSI: American National Standards Institute.
- B. ASCE: American Society of Civil Engineers.
- C. HMMA: Hollow Metal Manufacturers Association.
- D. NAAMM: National Association of Architectural Metal Manufacturers.
- E. NFPA: National Fire Protection Association.
- F. SCIF: Sensitive Compartmented Information Facility.
- G. SDI: Steel Door Institute.
- H. UL: Underwriters Laboratories.

1.04 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- B. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors 2018.
- C. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100) 2017.
- D. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames 2020.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- F. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable 2021a.
- G. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength 2018a.
- H. ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.
- I. NAAMM HMMA 840 - Guide Specifications For Receipt, Storage and Installation of Hollow Metal Doors and Frames 2017.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced standards/guidelines.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Provide hollow metal doors and frames from SDI Certified manufacturer: <https://steeldoor.org/sdi-certified/#sle>.
- B. Maintain at project site copies of reference standards relating to installation of products specified.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hollow Metal Doors and Frames:
 - 1. Ceco Door, an Assa Abloy Group company; _____: www.assaabloydss.com/#sle.
 - 2. Curries, an Assa Abloy Group company; _____: www.assaabloydss.com/#sle.
 - 3. Mesker, dormakaba Group; FDJ Series Drywall Frames:
www.meskeropeningsgroup.com/#sle.
 - 4. Republic Doors, an Allegion brand; _____: www.republicdoor.com/#sle.
 - 5. Steelcraft, an Allegion brand; _____: www.allegion.com/#sle.
 - 6. Substitutions: See Section 016000 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS

- A. Requirements for Hollow Metal Doors and Frames:
 - 1. Steel Sheet: Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
 - 2. Accessibility: Comply with ICC A117.1 and ADA Standards.
- B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 HOLLOW METAL DOORS

- A. Interior Doors, Non-Fire-Rated:
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 1 - Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 20 gauge, 0.032 inch (0.8 mm), minimum.
 - e. Zinc Coating: A60/ZF180 galvanized coating; ASTM A653/A653M.
 - 2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
 - 3. Door Thickness: 1-3/4 inches (44.5 mm), nominal.
 - 4. Door Face Sheets: Flush.
 - 5. Door Finish: Factory primed and field finished.

2.04 HOLLOW METAL FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
 - 1. Terminated Stops: Provide at interior doors; closed end stop terminated 6 inch (150 mm), maximum, above floor at 45 degree angle.
 - 2. Frame Metal Thickness: 14 gauge, 0.067 inch (1.7 mm), minimum.
 - 3. Frame Finish: Factory primed and field finished.

2.05 FINISHES

- A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

2.06 ACCESSORIES

- A. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.
- B. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Verify that finished walls are in plane to ensure proper door alignment.

3.02 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B. Coordinate frame anchor placement with wall construction.
- C. Install door hardware as specified in Section 087100.

3.03 TOLERANCES

- A. Maximum Diagonal Distortion: 1/16 inch (1.6 mm) measured with straight edge, corner to corner.

3.04 ADJUSTING

- A. Adjust for smooth and balanced door movement.
- B. Test sound control doors for force to close, latch, and unlatch; adjust as necessary in compliance with requirements.

END OF SECTION 081113

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**SECTION 081433
STILE AND RAIL WOOD DOORS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wood doors, stile and rail design; fire rated, non-fire rated, and _____.

1.02 RELATED REQUIREMENTS

- A. Section 062000 - Finish Carpentry: Wood door frames.
- B. Section 081113 - Hollow Metal Doors and Frames.
- C. Section 087100 - Door Hardware.

1.03 REFERENCE STANDARDS

- A. AWI (QCP) - Quality Certification Program Current Edition.
- B. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition 2014, with Errata (2016).
- C. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards 2021, with Errata.
- D. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives 2022.
- E. UL 1784 - Standard for Air Leakage Tests of Door Assemblies Current Edition, Including All Revisions.
- F. WDMA I.S. 6A - Interior Architectural Wood Stile and Rail Doors 2013.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Indicate stile and rail core materials and construction; veneer species, type and characteristics.
- C. Shop Drawings: Illustrate door opening criteria, elevations, sizes, types, swings, undercuts required, special beveling, special blocking for hardware, factory machining criteria, factory finishing criteria, cutouts for glazing, cutouts for louvers, cutouts for _____, and _____.
- D. Samples: Submit two samples of door veneer, 6 by 6 inches (152 by 152 mm) in size illustrating wood grain, stain color, and sheen.
- E. Certificate: Submit labels and certificates required by quality assurance and quality control programs.
- F. Manufacturer's qualification statement.
- G. Installer's qualification statement.
- H. Warranty, executed in Owner's name.

1.05 QUALITY ASSURANCE

- A. Maintain one copy of specified door quality standard on site for review during installation and finishing.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section, with not less than three years of documented experience.
 - 1. Accredited participant in specified certification program prior to commencement of fabrication and throughout duration of project.
- C. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.
- D. Quality Certification:
 - 1. Comply with AWI (QCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.awiqcp.org/#sle.
 - 2. Provide labels or certificates indicating that installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.

3. Provide designated labels on shop drawings as required by certification program.
4. Provide designated labels on installed products as required by certification program.
5. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Package, deliver, and store doors in accordance with quality standard specified.
- B. Accept doors on site in manufacturer's packaging, and inspect for damage.
- C. Protect doors with resilient packaging sealed with heat shrunk plastic; do not store in damp or wet areas or areas where sunlight might bleach veneer; seal top and bottom edges with tinted sealer if stored more than one week, and break seal on site to permit ventilation.

1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Interior Doors: Provide manufacturer's warranty for the life of the installation.
- C. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, telegraphing core construction, and _____.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Stile and Rail Wood Doors:
 1. Karona, Inc; ____: www.karonadoor.com/#sle.
 2. Masonite Architectural; Aspiro Authentic Stile & Rail Doors: www.architectural.masonite.com/#sle.
 3. VT Industries, Inc; ____: www.vtindustries.com/#sle.
 4. Substitutions: See Section 016000 - Product Requirements.

2.02 DOORS

- A. Quality Standard: Custom Grade, Heavy Duty performance, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless otherwise indicated.
- B. Interior Doors: 1-3/8 inches (34.93 mm) thick unless otherwise indicated; solid lumber construction; mortise and tenon joints. Transparent or opaque finish as indicated on drawings.

2.03 DOOR AND PANEL FACINGS

- A. Adhesive: Type I - Waterproof.

2.04 DOOR CONSTRUCTION

- A. Vertical Exposed Edge of Stiles: Of same species as veneer facing.
- B. Bond edge banding to cores.
- C. Smoke and Draft Control Doors (Indicated as "S" on Drawings): In addition to required fire rating, provide stile and rail door assemblies tested in accordance with UL 1784 with maximum air leakage of 3.0 cfm per sq ft (0.01524 cu m/s/sq m) of door opening at 0.10 inch water guage (24.9 Pa) pressure at both ambient and elevated temperatures for 'S' label; if necessary, provide additional gasketing or edge sealing.

2.05 FINISHES

- A. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:
 1. Transparent:
 2. Opaque:

2.06 ACCESSORIES

- A. Wood Door Frames: See Section 062000.
- B. Door Hardware: See Section 087100.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Do not install doors in frame openings that are not plumb or are out of tolerance for size or alignment.

3.02 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions and specified quality standards.
 - 1. Install smoke and draft control doors in accordance with NFPA 105 requirements.
- B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
- C. Machine cut for hardware.
- D. Coordinate installation of doors with installation of frames and hardware.

3.03 TOLERANCES

- A. Comply with specified quality standard for fit, clearance, and joinery tolerances.

3.04 ADJUSTING

- A. Adjust doors for smooth and balanced door movement.
- B. Adjust closers for full closure.

3.05 SCHEDULE - SEE DRAWINGS

END OF SECTION 081433

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**SECTION 087100
DOOR HARDWARE**

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Mechanical and electrified door hardware
 - 2. Electronic access control system components
- B. Section excludes:
 - 1. Windows
 - 2. Cabinets (casework), including locks in cabinets
 - 3. Signage
 - 4. Toilet accessories
 - 5. Overhead doors
- C. Related Sections:
 - 1. Division 01 Section "Alternates" for alternates affecting this section.
 - 2. Division 06 Section "Rough Carpentry"
 - 3. Division 06 Section "Finish Carpentry"
 - 4. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
 - 5. Division 08 Sections:
 - a. "Metal Doors and Frames"
 - b. "Flush Wood Doors"
 - c. "Stile and Rail Wood Doors"
 - d. "Aluminum-Framed Entrances and Storefronts"
 - 6. Division 26 "Electrical" sections for connections to electrical power system and for low-voltage wiring.
 - 7. Division 28 "Electronic Safety and Security" sections for coordination with other components of electronic access control system and fire alarm system.

1.02 REFERENCES

- A. UL LLC
 - 1. UL 10B - Fire Test of Door Assemblies
 - 2. UL 10C - Positive Pressure Test of Fire Door Assemblies
 - 3. UL 1784 - Air Leakage Tests of Door Assemblies
 - 4. UL 305 - Panic Hardware
- B. DHI - Door and Hardware Institute
 - 1. Sequence and Format for the Hardware Schedule
 - 2. Recommended Locations for Builders Hardware
 - 3. Keying Systems and Nomenclature
 - 4. Installation Guide for Doors and Hardware
- C. NFPA – National Fire Protection Association
 - 1. NFPA 70 – National Electric Code
 - 2. NFPA 80 – 2016 Edition – Standard for Fire Doors and Other Opening Protectives
 - 3. NFPA 101 – Life Safety Code
 - 4. NFPA 105 – Smoke and Draft Control Door Assemblies
 - 5. NFPA 252 – Fire Tests of Door Assemblies
- D. ANSI - American National Standards Institute
 - 1. ANSI A117.1 – 2017 Edition – Accessible and Usable Buildings and Facilities
 - 2. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties
 - 3. ANSI/BHMA A156.28 - Recommended Practices for Keying Systems
 - 4. ANSI/WDMA I.S. 1A - Interior Architectural Wood Flush Doors

5. ANSI/SDI A250.8 - Standard Steel Doors and Frames

1.03 SUBMITTALS

- A. General:
1. Submit in accordance with Conditions of Contract and Division 01 Submittal Procedures.
 2. Prior to forwarding submittal:
 - a. Review drawings and Sections from related trades to verify compatibility with specified hardware.
 - b. Highlight, encircle, or otherwise specifically identify on submittals: deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.
- B. Action Submittals:
1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
 2. Riser and Wiring Diagrams: After final approval of hardware schedule, submit details of electrified door hardware, indicating:
 - a. Wiring Diagrams: For power, signal, and control wiring and including:
 - 1) Details of interface of electrified door hardware and building safety and security systems.
 - 2) Schematic diagram of systems that interface with electrified door hardware.
 - 3) Point-to-point wiring.
 - 4) Risers.
 3. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated and tagged with full description for coordination with schedule.
 - a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
 4. Door Hardware Schedule:
 - a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
 - b. Submit under direct supervision of a Door Hardware Institute (DHI) certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.
 - c. Indicate complete designations of each item required for each opening, include:
 - 1) Door Index: door number, heading number, and Architect's hardware set number.
 - 2) Quantity, type, style, function, size, and finish of each hardware item.
 - 3) Name and manufacturer of each item.
 - 4) Fastenings and other pertinent information.
 - 5) Location of each hardware set cross-referenced to indications on Drawings.
 - 6) Explanation of all abbreviations, symbols, and codes contained in schedule.
 - 7) Mounting locations for hardware.
 - 8) Door and frame sizes and materials.
 - 9) Degree of door swing and handing.
 - 10) Operational Description of openings with electrified hardware covering egress, ingress (access), and fire/smoke alarm connections.
 5. Key Schedule:
 - a. After Keying Conference, provide keying schedule that includes levels of keying, explanations of key system's function, key symbols used, and door numbers controlled.

- b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
 - c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
 - d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
 - e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
 - f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.
- C. Informational Submittals:
1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
 2. Provide Product Data:
 - a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
 - b. Include warranties for specified door hardware.
- D. Closeout Submittals:
1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
 - a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
 - b. Catalog pages for each product.
 - c. Final approved hardware schedule edited to reflect conditions as installed.
 - d. Final keying schedule
 - e. Copy of warranties including appropriate reference numbers for manufacturers to identify project.
 - f. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.
- E. Inspection and Testing:
1. Submit written reports to the Owner and Authority Having Jurisdiction (AHJ) of the results of functional testing and inspection for:
 - a. Fire door assemblies, in compliance with NFPA 80.
 - b. Required egress door assemblies, in compliance with NFPA 101.

1.04 QUALITY ASSURANCE

- A. Qualifications and Responsibilities:
1. Supplier: Recognized architectural hardware supplier with a minimum of 5 years documented experience supplying both mechanical and electromechanical door hardware similar in quantity, type, and quality to that indicated for this Project. Supplier to be recognized as a factory direct distributor by the manufacturer of the primary materials with a warehousing facility in the Project's vicinity. Supplier to have on staff, a certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
 2. Installer: Qualified tradesperson skilled in the application of commercial grade hardware with experience installing door hardware similar in quantity, type, and quality as indicated for this Project.
 3. Architectural Hardware Consultant: 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 meets these requirements:
 - a. For door hardware: DHI certified AHC or DHC.
 - b. Can provide installation and technical data to Architect and other related subcontractors.

- c. Can inspect and verify components are in working order upon completion of installation.
 - d. Capable of producing wiring diagram and coordinating installation of electrified hardware with Architect and electrical engineers.
 4. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.
 - B. Certifications:
 1. Fire-Rated Door Openings:
 - a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.
 - b. Provide only items of door hardware that are listed products tested by UL LLC, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.
 2. Smoke and Draft Control Door Assemblies:
 - a. Provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105
 - b. Comply with the maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.
 3. Electrified Door Hardware
 - a. Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.
 4. Accessibility Requirements:
 - a. Comply with governing accessibility regulations cited in "REFERENCES" article 087100, 1.02.D3 herein for door hardware on doors in an accessible route. This project must comply with all Federal Americans with Disability Act regulations and all Local Accessibility Regulations.
 - C. Pre-Installation Meetings
 1. Keying Conference
 - a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
 - 1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 - 2) Preliminary key system schematic diagram.
 - 3) Requirements for key control system.
 - 4) Requirements for access control.
 - 5) Address for delivery of keys.
 2. Pre-installation Conference
 - a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Inspect and discuss preparatory work performed by other trades.
 - c. Inspect and discuss electrical roughing-in for electrified door hardware.
 - d. Review sequence of operation for each type of electrified door hardware.
 - e. Review required testing, inspecting, and certifying procedures.
 - f. Review questions or concerns related to proper installation and adjustment of door hardware.
 3. Electrified Hardware Coordination Conference:
 - a. Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping.

- B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer's original packaging.
- C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
- D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.
- E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.
- F. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.06 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.
- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

1.07 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.
 - 1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.
 - 2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer's published listings.
 - a. Mechanical Warranty
 - 1) Locks
 - (a) Schlage L Series: 3 years
 - (b) Schlage ND Series: 10 years
 - 2) Closers
 - (a) LCN 4000 Series: 30 years

1.08 MAINTENANCE

- A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.
- B. Turn over unused materials to Owner for maintenance purposes.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. The Owner requires use of certain products for their unique characteristics and project suitability to ensure continuity of existing and future performance and maintenance standards. After investigating available product offerings, the Awarding Authority has elected to prepare proprietary specifications. These products are specified with the notation: "No Substitute."
 - 1. Where "No Substitute" is noted, submittals and substitution requests for other products will not be considered.
- B. Approval of alternate manufacturers and/or products other than those listed as "Scheduled Manufacturer" or "Acceptable Manufacturers" in the individual article for the product category are only to be considered by official substitution request in accordance with section 01 25 00.

- C. Approval of products from manufacturers indicated in "Acceptable Manufacturers" is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.
- D. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.02 MATERIALS

- A. Fabrication
 - 1. Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. provide screws according to manufacturer's recognized installation standards for application intended.
 - 2. Finish exposed screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
 - 3. Provide concealed fasteners wherever possible for hardware units exposed when door is closed. Coordinate with "Metal Doors and Frames", "Flush Wood Doors", "Stile and Rail Wood Doors" to ensure proper reinforcements. Advise the Architect where visible fasteners, such as thru bolts, are required.
- B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.
 - 1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.
- C. Cable and Connectors:
 - 1. Where scheduled in the hardware sets, provide each item of electrified hardware and wire harnesses with number and gage of wires enough to accommodate electric function of specified hardware.
 - 2. Provide Molex connectors that plug directly into connectors from harnesses, electric locking and power transfer devices.
 - 3. Provide through-door wire harness for each electrified locking device installed in a door and wire harness for each electrified hinge, electrified continuous hinge, electrified pivot, and electric power transfer for connection to power supplies.

2.03 HINGES

- A. Manufacturers and Products:
 - 1. Scheduled Manufacturer and Product:
 - a. Ives 5BB series
 - 2. Acceptable Manufacturers and Products:
 - a. Hager BB1191/1279 series
 - b. McKinney TB series
 - c. Best FBB series
- B. Requirements:
 - 1. Provide hinges conforming to ANSI/BHMA A156.1.
 - 2. Provide five knuckle, ball bearing hinges.
 - 3. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
 - a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
 - b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high
 - 4. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
 - a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
 - 5. 2 inches or thicker doors:
 - a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
 - 6. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.

7. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
8. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - a. Steel Hinges: Steel pins
 - b. Non-Ferrous Hinges: Stainless steel pins
 - c. Out-Swinging Exterior Doors: Non-removable pins
 - d. Out-Swinging Interior Lockable Doors: Non-removable pins
 - e. Interior Non-lockable Doors: Non-rising pins
9. Provide hinges with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component. Provide mortar guard for each electrified hinge specified.

2.04 FLUSH BOLTS

- A. Manufacturers:
 1. Scheduled Manufacturer:
 - a. Ives
 2. Acceptable Manufacturers:
 - a. Rockwood
 - b. Trimco
- B. Requirements:
 1. Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless-steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dust-proof strikes at each bottom flush bolt.

2.05 COORDINATORS

- A. Manufacturers:
 1. Scheduled Manufacturer:
 - a. Ives
 2. Acceptable Manufacturers:
 - a. Trimco
 - b. Rockwood
- B. Requirements:
 1. Where pairs of doors are equipped with automatic flush bolts, an astragal, or other hardware that requires synchronized closing of the doors, provide bar-type coordinating device, surface applied to underside of stop at frame head.
 2. Provide filler bar of correct length for unit to span entire width of opening, and appropriate brackets for parallel arm door closers, surface vertical rod exit device strikes, or other stop mounted hardware. Factory-prepared coordinators for vertical rod devices as specified.

2.06 MORTISE LOCKS

- A. Manufacturers and Products:
 1. Scheduled Manufacturer and Product:
 - a. Schlage L9000 series
 2. Acceptable Manufacturers and Products:
 - a. Per Architect's approval
- B. Requirements:
 1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1, and UL Listed for 3-hour fire doors.
 2. Indicators: Where specified, provide indicator window measuring a minimum 2-inch x 1/2 inch with 180-degree visibility. Provide messages color-coded with full text and/or symbols, as scheduled, for easy visibility.

3. Provide locks manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance.
4. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to "KEYING" article, herein.
5. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1-inch (25 mm) throw, constructed of stainless steel.
6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim. Provide electrified options as scheduled in the hardware sets. Where scheduled, provide switches and sensors integrated into the locks and latches.
7. Provide motor based electrified locksets that comply with the following requirements:
 - a. Universal input voltage – single chassis accepts 12 or 24VDC to allow for changes in the field without changing lock chassis.
 - b. Fail Safe/Fail Secure – changing mode between electrically locked (fail safe) and electrically unlocked (fail secure) is field selectable without opening the lock case.
 - c. Low maximum current draw – maximum 0.4 amps to allow for multiple locks on a single power supply.
 - d. Low holding current – maximum 0.01 amps to produce minimal heat, eliminate "hot levers" in electrically locked applications, and to provide reliable operation in wood doors that provide minimal ventilation and air flow.
 - e. Connections – provide quick-connect Molex system standard.
8. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.
 - a. Lever Design: 06.

2.07 CYLINDRICAL LOCKS – GRADE 1

- A. Manufacturers and Products:
 1. Scheduled Manufacturer and Product:
 - a. Schlage ND series
 2. Acceptable Manufacturers and Products:
 - a. Per Architect's approval
- B. Requirements:
 1. Provide cylindrical locks conforming to ANSI/BHMA A156.2 Series 4000, Grade 1, and UL Listed for 3-hour fire doors.
 2. Cylinders: Refer to "KEYING" article, herein.
 3. Provide locks with standard 2-3/4 inches (70 mm) backset, unless noted otherwise, with 1/2-inch latch throw. Provide proper latch throw for UL listing at pairs.
 4. Provide locksets with separate anti-rotation thru-bolts, and no exposed screws.
 5. Provide independently operating levers with two external return spring cassettes mounted under roses to prevent lever sag.
 6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
 7. Provide electrified options as scheduled in the hardware sets.
 8. Lever Trim: Solid cast levers without plastic inserts and wrought roses on both sides.
 - a. Lever Design: Rhodes.

2.08 MAGNETIC LOCKS

- A. Manufacturers:
 1. Scheduled Manufacturer:
 - a. Schlage
 2. Acceptable Manufacturers:
 - a. Per Architect's approval
- B. Requirements:
 1. Provide magnetic locks certified to meet ANSI/BHMA A156.23 classification criteria, UL10C, and UL1034 for burglary-resistant electronic locking mechanisms.

2. Provide magnetic locks equipped with SPDT Magnetic Bond Sensing device, where specified, to monitor whether enough magnetic holding force exists to ensure adequate locking and SPDT Door Status Monitor device, where specified, to monitor whether door is open or closed. Provide bond sensors fully concealed within electromagnet to resist tampering or damage.
3. Provide fasteners, mounting brackets, and spacer bars required for mounting and details.
4. Provide power supply recommended and approved by manufacturer of magnetic locks.
5. Where magnetic locks are scheduled, provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by manufacturer of magnetic locks for each individual leaf. Switches control both doors simultaneously at pairs. Locate controls as directed by Architect.

2.09 CYLINDERS

- A. Manufacturers:
 1. Scheduled Manufacturer and Product:
 - a. Match existing type and keyway
 2. Acceptable Manufacturers and Products:
 - a. No Substitute
- B. Requirements:
 1. Provide cylinders/cores to match Owner's existing key system, compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer's series as indicated. Refer to "KEYING" article, herein.

2.10 KEYING

- A. Scheduled System:
 1. Existing factory registered system:
 - a. Provide cylinders/cores keyed into Owner's existing factory registered keying system. Comply with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.
- B. Requirements:
 1. Construction Keying:
 - a. Temporary Construction Cylinder Keying.
 - 1) Provide construction cores/cylinders per Owner's request.
 - 2) Owner or Owner's Representative will void operation of temporary construction keys.
 2. Permanent Keying:
 - a. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
 - 1) Master Keying system as directed by the Owner.
 - b. Forward biting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
 - c. Provide keys with the following features:
 - 1) Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
 - 2) Patent Protection: Keys and blanks protected by one or more utility patent(s).
 - 3) Geographically Exclusive: Where High Security or Security cylinders/cores are indicated, provide nationwide, geographically exclusive key system complying with the following restrictions.
 - d. Identification:
 - 1) Mark permanent cylinders/cores and keys with applicable blind code for identification. Do not provide blind code marks with actual key cuts.
 - 2) Identification stamping provisions must be approved by the Architect and Owner.
 - 3) Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to

- enforce the patent protection.
- 4) Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
- 5) Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.
- e. Quantity: Furnish in the following quantities.
 - 1) Change (Day) Keys: 3 per cylinder/core.
 - 2) Master Keys: 6.

2.11 KEY CONTROL SYSTEM

- A. Manufacturers:
 - 1. Scheduled Manufacturer:
 - a. Telkee
 - 2. Acceptable Manufacturers:
 - a. HPC
 - b. Lund
- B. Requirements:
 - 1. Provide key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of number of locks required for Project.
 - a. Provide complete cross index system set up by hardware supplier, and place keys on markers and hooks in cabinet as determined by final key schedule.
 - b. Provide hinged-panel type cabinet for wall mounting.

2.12 DOOR CLOSERS

- A. Manufacturers and Products:
 - 1. Scheduled Manufacturer and Product:
 - a. LCN 4040XP series
 - 2. Acceptable Manufacturers and Products:
 - a. Per Architect's approval
- B. Requirements:
 - 1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
 - 2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
 - 3. Cylinder Body: 1-1/2-inch (38 mm) diameter piston with 5/8-inch (16 mm) diameter double heat-treated pinion journal. QR code with a direct link to maintenance instructions.
 - 4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
 - 5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards. Provide snap-on cover clip, with plastic covers, that secures cover to spring tube.
 - 6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck. Provide graphically labelled instructions on the closer body adjacent to each adjustment valve. Provide positive stop on reg valve that prevents reg screw from being backed out.
 - 7. Provide closers with solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers.
 - 8. Pressure Relief Valve (PRV) Technology: Not permitted.
 - 9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).

10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.13 PROTECTION PLATES

- A. Manufacturers:
 1. Scheduled Manufacturer:
 - a. Ives
 2. Acceptable Manufacturers:
 - a. Trimco
 - b. Rockwood
- B. Requirements:
 1. Provide protection plates with a minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
 2. Sizes plates 2 inches (51 mm) less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch (25 mm) less width of door on pairs without a mullion or edge guards.
 3. At fire rated doors, provide protection plates over 16 inches high with UL label.

2.14 DOOR STOPS AND HOLDERS

- A. Manufacturers:
 1. Scheduled Manufacturer:
 - a. Ives
 2. Acceptable Manufacturers:
 - a. Trimco
 - b. Rockwood
- B. Provide door stops at each door leaf:
 1. Provide wall stops wherever possible. Provide concave type where lockset has a push button of thumbturn.
 2. Where a wall stop cannot be used, provide universal floor stops.
 3. Where wall or floor stop cannot be used, provide overhead stop.
 4. Provide roller bumper where doors open into each other and overhead stop cannot be used.

2.15 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

- A. Manufacturers:
 1. Scheduled Manufacturer:
 - a. Zero International
 2. Acceptable Manufacturers:
 - a. National Guard
 - b. Pemko
- B. Requirements:
 1. Provide thresholds, weather-stripping, and gasketing systems as specified and per architectural details. Match finish of other items.
 2. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
 3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.
 4. Size thresholds 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width unless otherwise specified in the hardware sets or detailed in the drawings.

2.16 SILENCERS

- A. Manufacturers:
 1. Scheduled Manufacturer:

- a. Ives
2. Acceptable Manufacturers:
 - a. Rockwood
 - b. Trimco
- B. Requirements:
 1. Provide "push-in" type silencers for hollow metal or wood frames.
 2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
 3. Omit where gasketing is specified.

2.17 FINISHES

- A. FINISH: BHMA 626/652 (US26D) AS SCHEDULED; EXCEPT:
 1. Hinges at Exterior Doors: BHMA 630 (US32D)
 2. Aluminum Geared Continuous Hinges: BHMA 628 (US28)
 3. Push Plates, Pulls, and Push Bars: BHMA 630 (US32D)
 4. Protection Plates: BHMA 630 (US32D)
 5. Overhead Stops and Holders: BHMA 630 (US32D)
 6. Door Closers: Powder Coat to Match
 7. Wall Stops: BHMA 630 (US32D)
 8. Latch Protectors: BHMA 630 (US32D)
 9. Weatherstripping: Clear Anodized Aluminum
 10. Thresholds: Mill Finish Aluminum
- B. FINISH: BHMA 606/633 (US4) AS SCHEDULED; EXCEPT:
 1. Door Closers: Powder Coat to Match
 2. Latch Protectors: BHMA 630 (US32D)
 3. Weatherstripping: Gold Anodized Aluminum
 4. Thresholds: Mill Finish Gold

PART 3 EXECUTION

3.01 EXAMINATION

- A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Verify doors, frames, and walls have been properly reinforced for hardware installation.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. 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. Interior Architectural Wood Flush Doors: ANSI/WDMA I.S. 1A
 4. Installation Guide for Doors and Hardware: DHI TDH-007-20
- B. Install door hardware in accordance with NFPA 80, NFPA 101 and provide post-install inspection, testing as specified in section 1.03.E unless otherwise required to comply with governing regulations.
- C. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- D. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.

- E. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
- F. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- G. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.
- H. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.
- I. Wiring: Coordinate with Division 26, ELECTRICAL and Division 28 ELECTRONIC SAFETY AND SECURITY sections for:
 - 1. Conduit, junction boxes and wire pulls.
 - 2. Connections to and from power supplies to electrified hardware.
 - 3. Connections to fire/smoke alarm system and smoke evacuation system.
 - 4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
 - 5. Connections to panel interface modules, controllers, and gateways.
 - 6. Testing and labeling wires with Architect's opening number.
- J. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
- K. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.
- L. Closer/holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
- M. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.
- N. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
- O. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.
- P. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- Q. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- R. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.

3.03 ADJUSTING

- A. Initial Adjustment: 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.
 - 1. Spring Hinges: Adjust to achieve positive latching when door can close freely from an open position of 30 degrees.
 - 2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
 - 3. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
- B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

3.04 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items per manufacturer's instructions to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.05 DOOR HARDWARE SCHEDULE

- A. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.
- B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.
- C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.
- D. Hardware Sets:

89308 OPT0302540 VERSION 1

LEGEND:

LINK TO CATALOG CUT SHEET

~ELECTRIFIED OPENING

HARDWARE GROUP NO. 01

FOR USE ON DOOR #(S):

131C					
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PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
1	EA	ACTUATOR PKG	8310-3860TW <input type="checkbox"/>	~		630	LCN
2	EA	MOUNT BOX	8310-868S (AS REQ'D) <input type="checkbox"/>				LCN
1	EA	BALANCE HARDWARE	REUSE EXISTING HARDWARE				

WIRELESS ACTUATOR IN ROUND SHAPE IS SPECIFIED.
FIELD VERIFY COMPATIBILITY OF ACTUATOR WITH THE EXISTING OPERATOR.
FIELD VERIFY EXISTING DOOR, FRAME AND HARDWARE CONDITIONS, AND PROVIDE HARDWARE AS NECESSARY

HARDWARE GROUP NO. 02

FOR USE ON DOOR #(S):

118	131A	133			
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PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
2	EA	MAGNETIC LOCK	M490P DBK450/490ATS/LED <input type="checkbox"/>	~		628	SCE
			12/24 VDC				

1	EA	CREDENTIAL READER	BY DIVISION 28.		~		
1	EA	PUSH BUTTON	625RDEX DA 12/24 VDC	<input type="checkbox"/>	~	630	SCE
1	EA	MOTION SENSOR/REQUEST TO EXIT	BY DIVISION 28.		~		
2	EA	DOOR CONTACT	BY DIVISION 28.		~		
1	EA	FIRE ALARM CONTACT	BY FIRE ALARM CONTRACTOR.		~		
1	EA	BALANCE HARDWARE	REUSE EXISTING HARDWARE				

OPERATION:

DOOR IS NORMALLY SECURED BY MAGNETIC LOCK
PRESENTING VALID CREDENTIAL TEMPORARILY RELEASES MAGNETIC LOCK FOR ENTRY
MOTION SENSOR OR PUSHING EXIT BUTTON TEMPORARILY RELEASES MAGNETIC LOCK FOR EXIT

DOOR IS UNSECURED UPON LOSS OF POWER TO THE MAGNETIC LOCK

HARDWARE GROUP NO. 03

FOR USE ON DOOR #(S):

004							
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PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5	<input type="checkbox"/>		652	IVE
2	EA	MANUAL FLUSH BOLT	FB457	<input type="checkbox"/>		626	IVE
1	EA	DUST PROOF STRIKE	DP1 OR DP2 AS REQ'D	<input type="checkbox"/>		626	IVE
1	EA	STOREROOM LOCK	ND80LD RHO	<input type="checkbox"/>		626	SCH
1	EA	KIL CYLINDER/CORETYPE AND SYSTEM	MATCH EXISTING			626	
1	EA	SURFACE CLOSER	4040XP	<input type="checkbox"/>		689	LCN
2	EA	WALL STOP	WS401/402CVX	<input type="checkbox"/>		626	IVE
1	EA	ASTRAGAL	43STST	<input type="checkbox"/>		STST	ZER
2	EA	SILENCER	SR64	<input type="checkbox"/>		GRY	IVE

HARDWARE GROUP NO. 04

FOR USE ON DOOR #(S):

010							
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PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
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3	EA	HINGE	5BB1HW 4.5 X 4.5	<input type="checkbox"/>		652	IVE
1	EA	STOREROOM LOCK	ND80LD RHO	<input type="checkbox"/>		626	SCH
1	EA	KIL CYLINDER/CORE	MATCH EXISTING TYPE AND SYSTEM			626	
1	EA	SURFACE CLOSER	4040XP	<input type="checkbox"/>		689	LCN
1	EA	WALL STOP	WS401/402CVX	<input type="checkbox"/>		626	IVE
3	EA	SILENCER	SR64	<input type="checkbox"/>		GRY	IVE

HARDWARE GROUP NO. 05

FOR USE ON DOOR #(S):

014							
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PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	<input type="checkbox"/>		652	IVE
1	EA	STOREROOM LOCK	ND80LD RHO	<input type="checkbox"/>		626	SCH
1	EA	KIL CYLINDER/CORE	MATCH EXISTING TYPE AND SYSTEM			626	
1	EA	SURFACE CLOSER	4040XP SHCUSH	<input type="checkbox"/>		689	LCN
3	EA	SILENCER	SR64	<input type="checkbox"/>		GRY	IVE

HARDWARE GROUP NO. 06

FOR USE ON DOOR #(S):

014A	016A						
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PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	<input type="checkbox"/>		652	IVE
1	EA	STOREROOM LOCK	ND80LD RHO	<input type="checkbox"/>		626	SCH
1	EA	KIL CYLINDER/CORE	MATCH EXISTING TYPE AND SYSTEM			626	
1	EA	SURFACE CLOSER	4040XP EDA	<input type="checkbox"/>		689	LCN
1	EA	WALL STOP	WS401/402CVX	<input type="checkbox"/>		626	IVE

3	EA	SILENCER	SR64	<input type="checkbox"/>		GRY	IVE
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HARDWARE GROUP NO. 07

FOR USE ON DOOR #(S):

013							
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PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	<input type="checkbox"/>		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	<input type="checkbox"/>		652	IVE
1	EA	PRIVACY LOCK	L9040 06A L583-363 L283-722	<input type="checkbox"/>		626	SCH
1	EA	SURFACE CLOSER	4040XP	<input type="checkbox"/>		689	LCN
1	EA	WALL STOP	WS401/402CVX	<input type="checkbox"/>		626	IVE
1	EA	GASKETING	488SBK PSA @ HEAD & JAMBS	<input type="checkbox"/>		BK	ZER

HARDWARE GROUP NO. 10

FOR USE ON DOOR #(S):

101							
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PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	<input type="checkbox"/>		FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5	<input type="checkbox"/>		633	IVE
1	EA	AUTO FLUSH BOLT	FB41P	<input type="checkbox"/>		606	IVE
1	EA	DUST PROOF STRIKE	DP1	<input type="checkbox"/>		606	IVE
1	EA	STOREROOM LOCK	ND80LD RHO	<input type="checkbox"/>		606	SCH
1	EA	KIL CYLINDER/CORETYPE AND SYSTEM	MATCH EXISTING			606	
1	EA	COORDINATOR	COR X FL	<input type="checkbox"/>		711	IVE
2	EA	SURFACE CLOSER	4040XP MC WMS	<input type="checkbox"/>		US4	LCN
2	EA	MOUNTING PLATE	4040XP-18 (AS REQ'D)	<input type="checkbox"/>		US4	LCN
2	EA	KICK PLATE	8400 6" X 1" LDW B-CS	<input type="checkbox"/>		606	IVE
2	EA	WALL STOP	WS401/402CVX	<input type="checkbox"/>		606	IVE
1	EA	GASKETING	488SBK PSA @ HEAD & JAMBS	<input type="checkbox"/>		BK	ZER

HARDWARE GROUP NO. 12

FOR USE ON DOOR #(S):

115					
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PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	<input type="checkbox"/>	633	IVE
1	EA	STOREROOM LOCK	ND80LD RHO	<input type="checkbox"/>	606	SCH
1	EA	KIL CYLINDER/CORE	MATCH EXISTING TYPE AND SYSTEM		606	
1	EA	SURFACE CLOSER	4040XP SCUSH MC WMS	<input type="checkbox"/>	US4	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA (AS REQ'D)	<input type="checkbox"/>	US4	LCN
3	EA	SILENCER	SR64	<input type="checkbox"/>	GRY	IVE

HARDWARE GROUP NO. 13

FOR USE ON DOOR #(S):

148					
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PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	<input type="checkbox"/>	633	IVE
1	EA	STOREROOM LOCK	ND80LD RHO	<input type="checkbox"/>	606	SCH
1	EA	KIL CYLINDER/CORE	MATCH EXISTING TYPE AND SYSTEM		606	
1	EA	SURFACE CLOSER	4040XP H MC WMS	<input type="checkbox"/>	US4	LCN
1	EA	MOUNTING PLATE	4040XP-18 (AS REQ'D)	<input type="checkbox"/>	US4	LCN
1	EA	WALL STOP	WS401/402CVX	<input type="checkbox"/>	606	IVE
3	EA	SILENCER	SR65	<input type="checkbox"/>	GRY	IVE

FIELD VERIFY EXISTING DOOR, FRAME AND HARDWARE CONDITIONS, AND PROVIDE HARDWARE AS NECESSARY

HARDWARE GROUP NO. 14

FOR USE ON DOOR #(S):

206	208	214	215	216	219
220	221	224	232	233	238
253	258	266	270	271	272A

272B	276A	276B	277	280		
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PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
1	EA	THRESHOLD	548G-OR PER SILL DETAILS	<input type="checkbox"/>		G	ZER
1	EA	BALANCE HARDWARE	REUSE EXISTING HARDWARE				

HARDWARE GROUP NO. 15

FOR USE ON DOOR #(S):

134						
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PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	<input type="checkbox"/>		633	IVE
1	EA	PASSAGE SET	ND10S RHO	<input type="checkbox"/>		606	SCH
1	EA	SURFACE CLOSER	4040XP EDA MC WMS	<input type="checkbox"/>		US4	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA (AS REQ'D)	<input type="checkbox"/>		US4	LCN
1	EA	WALL STOP	WS401/402CVX	<input type="checkbox"/>		606	IVE
1	EA	GASKETING	488SBK PSA @ HEAD & JAMBS	<input type="checkbox"/>		BK	ZER

HARDWARE GROUP NO. 16

FOR USE ON DOOR #(S):

116B	119					
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PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
1	EA	NOTE	CASED OPENING, NO HARDWARE IS NEEDED				

HARDWARE GROUP NO. 17

FOR USE ON DOOR #(S):

154						
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PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
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1	EA	NOTE	ALL HARDWARE BY SLIDING DOOR MANUFACTURER				
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HARDWARE GROUP NO. 18

FOR USE ON DOOR #(S):

123	127	132	133B	133C	137
137A	140	152	227	239	245
246	247	248	249	250	251
252	254	288	289		

PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
1	EA	NOTE	REUSE EXISTING HARDWARE				

FIELD VERIFY EXISTING DOOR, FRAME AND HARDWARE CONDITIONS, AND PROVIDE HARDWARE AS NECESSARY

HARDWARE GROUP NO. 19

FOR USE ON DOOR #(S):

116	136	143A	143B	149	
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PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
1	EA	NOTE	REUSE EXISTING HARDWARE				

FIELD VERIFY EXISTING DOOR, FRAME AND HARDWARE CONDITIONS, AND PROVIDE HARDWARE AS NECESSARY

HARDWARE GROUP NO. A01

FOR USE ON DOOR #(S):

106					
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PROVIDE EACH DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER			FINISH	MFR
1	EA	ACTUATOR PKG	8310-3857TW □	~		630	LCN
1	EA	BALANCE HARDWARE	REUSE EXISTING HARDWARE				

**WIRELESS ACTUATOR IN SQUARE SHAPE IS SPECIFIED
FIELD VERIFY COMPATIBILITY OF ACTUATOR WITH THE EXISTING OPERATOR.
FIELD VERIFY EXISTING DOOR, FRAME, AND HARDWARE CONDITIONS, AND PROVIDE HARDWARE AS NECESSARY**

END OF SECTION 087100

**SECTION 087100.10
DOOR HARDWARE INDEX**

SCHEDULE

1.01 SECTION INCLUDES

DOOR #	HARDWARE SET #
004	03
010	04
013	07
014	05
014A	06
016A	06
101	10
106	A01
115	12
116	19
116B	16
118	02
119	16
123	18
127	18
131A	02
131C	01
132	18
133	02
133B	18
133C	18
134	15
136	19
137	18
137A	18
140	18
143A	19
143B	19
148	13
149	19
152	18
154	17
206	14
208	14
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END OF SECTION 087100.10

**SECTION 090320
HISTORIC TREATMENT OF PLASTER**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Replication of cast gypsum plasterwork.
- B. Related Requirements:
 - 1. Section 013591 "Historic Treatment Procedures" for general historic treatment requirements.
 - 2. Section 061000 "Rough Carpentry" for wood framing, grounds, and furring that support lath and plaster.
 - 3. Section 092216 "Non-Structural Metal Framing" for non-load-bearing steel framing and furring that support lath and plaster.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to historic treatment of plaster including, but not limited to, the following:
 - a. Verify historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, colors, patterns, and sequencing.
 - c. Fire-protection plan.
 - d. Plasterwork historic treatment program.
 - e. Coordination with building occupants.

1.04 SEQUENCING AND SCHEDULING

- A. Perform historic treatment of plaster in the following sequence, which includes work specified in this and other Sections:
 - 1. Dismantle existing surface-mounted objects and hardware that overlie plaster surfaces except items indicated to remain in place. Tag items with location identification and protect.
 - 2. Verify that temporary protections have been installed.
 - 3. Examine condition of plaster surfaces.
 - 4. Clean plaster surface and remove paint and other finishes to the extent required.
 - 5. Repair and replace existing plaster and supports to the degree required for a uniform, tightly adhered surface on which to paint or apply other finishes.
 - 6. Cure repaired surfaces and allow them to dry for proper finishing.
 - 7. Paint and apply other finishes.
 - 8. Reinstall dismantled surface-mounted objects and hardware unless otherwise indicated.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include recommendations for product application and use.
- B. Shop Drawings: For each configuration of new or replicated plaster molding and ornament required for the work.
 - 1. Include plans, elevations, and sections that show locations and extent of work.
 - 2. Show full-size details of configurations, joint locations, and attachments to other work.
- C. Samples for Initial Selection: For each exposed product that will be exposed and not be painted or otherwise finished and for each color and texture specified.
- D. Samples for Verification: For the following products:

1. Cast Plaster: Each type and form of cast-plaster fabrication.
 - a. Patterns for Casting: Before manufacturing cast-plaster fabrications, submit the actual patterns from which molds will be made for casting new units. Package and ship to prevent loss or damage or make patterns available for inspection by Architect at fabrication plant.
 - b. Cast-Plaster Fabrications: Provide one unit of each shape and surface design, suitable and ready for installation. Submit unit samples after acceptance of patterns for casting.
2. Linear Moldings: 24-inch-long section of each configuration wet-applied molding with finished joint. Show complete pattern and applied nonlinear cast-plaster shapes, if any.
3. Nonlinear Shapes: Full-size unit of each configuration.
4. Wood Lath: 18-inch-long section.
5. Metal Lath: 18 inchesquare.
6. Accessories: Each type in manufacturer's standard size.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified historic treatment specialist.
- B. Plasterwork Historic Treatment Program: Submit before work begins.

1.07 QUALITY ASSURANCE

- A. Historic Treatment Specialist Qualifications: A qualified historic plastering specialist with expertise in matching and performing the types of historic plasterwork repairs required. Experience only in installing and repairing new plasterwork, veneer plaster, or gypsum board is insufficient experience for historic treatment work.
- B. Plasterwork Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for historic treatment work and protection of surrounding materials and Project site.
 1. Include methods and procedures to protect plastered surfaces from damage caused by construction operations, including, but not limited to, exposure to moisture, vibration, mechanical damage, and soiling.
 2. If materials and methods other than those indicated are proposed for any phase of historic treatment work, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.
- C. Mockups: Prepare mockups of historic treatment processes for each type of plaster repair and reconstruction work to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation.
 1. Locate mockups on existing surfaces where directed by Architect.
 2. Number and Size: Two wall surfaces of at least 50 sq. ft. or approximately 48 inches in least dimension to represent surfaces and conditions for application of each type of plaster repair and reconstruction under same conditions as the completed Work. Include at least the following:
 - a. Patch 10-sq. ft. area of wet-applied plaster replacement with grooves simulating stone joints, as indicated.
 - b. Install 6 linear ft. of wet-applied plaster molding.
 - c. Install 6 linear ft. of cast-plaster molding, but not less than two cast units.
 - d. Repair 3 linear ft. of plaster cracks.
 - e. Reattach 4-sq. ft. area of delaminated plaster that has not fallen.
 3. Simulate finished lighting conditions for review of mockups.
 4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.
- B. Store materials on elevated platforms, under cover, and in a dry location with ambient temperatures continuously maintained at not less than 45 deg F.
- C. Store hydrated lime and factory-prepared lime putty in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.
- D. Store materials not in use in tightly covered containers.
- E. Store lime putty covered with water in sealed containers.
- F. Store sand where grading and other required characteristics can be maintained and contamination avoided.
- G. Handle cast-plaster fabrications to prevent overstressing, chipping, defacement, and other damage.

1.09 FIELD CONDITIONS

- A. Comply with plaster-material manufacturers' written instructions. For gypsum plaster, also comply with ASTM C842 requirements.
- B. Temperatures: Maintain temperatures in work areas at not less than 55 deg F or greater than 80 deg F for at least seven days before application of plaster, continuously during application, and for seven days after plaster has set or until plaster has dried.
- C. Conditioning: Acclimatize cast-plaster fabrications to ambient temperature and humidity of spaces in which they are installed. Remove packaging and move units into installation spaces not less than 48 hours before installing them.
- D. Field Measurements: Where cast-plaster fabrications are 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.
- E. Avoid conditions that result in plaster drying out too quickly.
 - 1. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
 - 2. Maintain relative humidity levels for prevailing ambient temperature that produce normal drying conditions.
 - 3. Ventilate work areas in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.

1.10 REUSABLE PLASTER MOLDS AND PATTERNS

- A. On completion of the manufacturing of cast units, deliver one unused or one cleaned and reusable mold of each shape and size of unit delivered to Project site. Deliver to a location and at a time determined by Owner, to become Owner's property.
- B. Identify each piece whether it was sized for casting lime- or gypsum-plaster fabrications and where the fabrications were used.
- C. Have molds delivered carefully packed; protected from dirt, moisture, and breakage; so as to arrive in usable, undamaged condition and enable long-term storage and possible future use.

PART 2 PRODUCTS

2.01 GYPSUM PLASTER MATERIALS

- A. Gypsum Materials:
 - 1. Lightweight Gypsum Ready-Mixed Plaster: ASTM C28/C28M, with mill-mixed perlite aggregate.
 - 2. Gypsum Neat Plaster: ASTM C28/C28M for use with job-mixed aggregates.
 - 3. Gypsum Wood-Fibered Plaster: ASTM C28/C28M.

4. High-Strength Gypsum Neat Plaster: ASTM C28/C28M; with a minimum, average, dry compressive strength of 2800 psi per ASTM C472 for a mix of 100 lb of plaster and 2 cu. ft. of sand.
 5. Gypsum Gaging Plaster. ASTM C28/C28M.
 6. High-Strength Gypsum Gaging Plaster: ASTM C28/C28M; with a minimum, average, dry compressive strength of 5000 psi per ASTM C472 for a neat mix.
 7. Gypsum Ready-Mixed Finish Plaster: ASTM C28/C28M; manufacturer's standard, mill-mixed, gaged, interior finish.
 8. Gypsum Keene's Cement: ASTM C61/C61M.
- B. Hydrated Lime: ASTM C206, Type S or Type N.
- C. Aggregates:
1. Aggregate for Base-Coat Plasters: ASTM C35, sand.
 2. Aggregate for Float Finishes: ASTM C35, sand; graded per ASTM C842.
- D. Fiber: 1/2 to 1 inch in length; composed of glass or polypropylene fiber; free of grease, waxes, and oils; and beaten well to separate fibers before blending into unfibered plaster material.
1. Proportion of Fiber to Unfibered Plaster Material: 3.5 oz./cu. ft. of unfibered plaster material, adjusted as required to produce a well-fibered, cohesive, spreadable, stiff mix with fibers uniformly distributed.
- E. Bonding Compound: ASTM C631.

2.02 LATH

- A. Wood Lath: 1/4 inch by 1-1/4 inch sound, straight-grained, wood strips
- B. Metal Lath:
1. Expanded-Metal Lath: ASTM C847, cold-rolled carbon-steel sheet, ASTM A653/A653M, G60, hot-dip galvanized zinc coated.
 - a. Diamond-Mesh Lath: Flat, 2.5 lb/sq. yd..

2.03 TRIM ACCESSORIES

- A. General: According to ASTM C841 for gypsum plaster; coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
- B. Metal Accessories:
1. Cornerite: Fabricated from expanded-metal lath with ASTM A653/A653M, G60, hot-dip galvanized zinc coating.
 2. Striplath: Fabricated from expanded-metal lath with ASTM A653/A653M, G60, hot-dip galvanized zinc coating.
 3. Cornerbeads: Fabricated from zinc or zinc-coated (galvanized) steel.
 - a. Small nose cornerbead with expanded flanges; use unless otherwise indicated.
 - b. Small nose cornerbead with perforated flanges; use on curved corners.
 - c. Small nose cornerbead with expanded flanges reinforced by perforated stiffening rib; use on columns and for finishing unit masonry corners.
 - d. Bull nose cornerbead, radius of 3/4 inch minimum, with expanded flanges; use at locations indicated on Drawings.
 4. Casing Beads: Fabricated from zinc or zinc-coated (galvanized) steel; square-edged style; with expanded flanges.
 5. Control Joints: Fabricated from zinc or zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
 6. Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
 7. Two-Piece Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch wide; with perforated flanges.

2.04 MISCELLANEOUS MATERIALS

- A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
- B. Fasteners for Attaching Lath to Substrates:
 - 1. For Lime Plaster: ASTM C1063.
 - 2. For Gypsum Plaster: ASTM C841.
 - 3. For Wood Lath: ASTM C841 requirements for wood-floor-runner or wood-furring fasteners unless otherwise indicated on Drawings.
- C. Wire Ties: ASTM A641/A641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch diameter, unless otherwise indicated.
- D. Plaster-Stabilization Materials: Acrylic emulsion(s) and related installation products shall have proven effectiveness in reattaching delaminated plaster and shall have been used previously by historic treatment specialist with successful results.
 - 1. Acrylic Emulsion(s), General: Aqueous emulsion(s) of acrylic polymer, adhesive to plaster and plaster substrates, nontoxic, and non-reemulsifiable after curing.
 - 2. Prewet Solution: Low-viscosity acrylic emulsion.
 - 3. Adhesive: Thickened acrylic emulsion; thickener as recommended in writing by resin manufacturer and historic treatment specialist.
- E. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
 - 1. Previous effectiveness in performing the work involved.
 - 2. Little possibility of damaging exposed surfaces.
 - 3. Consistency of each application.
 - 4. Uniformity of the resulting overall appearance.
 - 5. Do not use products or tools that could do the following:
 - a. Remove, alter, or in any way harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in contract.
 - b. Leave an unintended residue on surfaces.

2.05 CAST-PLASTER FABRICATIONS

- A. General: Fabricate cast-plaster units with uniformly finished surfaces and sharply defined details; repair hollows, voids, scratches, and other surface imperfections.
 - 1. Fabricate units of sizes and shapes to match similar existing plasterwork unless otherwise indicated.
 - 2. Fabricate units in lengths and sizes that minimize number of joints between abutting units unless otherwise indicated.
 - 3. Configure joints between units so that they may be finished flush or otherwise concealed inconspicuously.
 - 4. Maximum deviation from true line, size, or shape shall be 1/16 inch, noncumulative.
- B. Composition: Fabricate units from gypsum-plaster materials. Reinforce units with fiber.
 - 1. Plaster Face: Molding plaster with or without aggregate as is standard with manufacturer for required surface finish.
 - 2. Plaster Backup: Molding plaster with or without aggregate, but with high-proportion of plaster-saturated fiber or fabric reinforcing as is standard with manufacturer.
- C. Thickness: Not less than 3/16-inch thickness of plaster material at any point, except for surface-applied, fine plaster tracery as indicated on Drawings.
- D. Finish: Smooth for paint finish.
- E. Embedments: Incorporate manufacturer's standard embedments for attaching units to supporting elements unless otherwise indicated. Place embedments to develop the full strength of cast-plaster fabrications. Cover embedments with not less than 3/16-inch thickness of reinforced plaster material.
- F. Joint-Treatment Materials: As recommended in writing by manufacturer.

PART 3 EXECUTION

3.01 HISTORIC TREATMENT SPECIALIST

- A. Historic Treatment Specialist Firms: Selected through Value Based Selection process.

3.02 HISTORIC TREATMENT OF PLASTER, GENERAL

- A. Historic Treatment Appearance Standard: Completed work is to have a uniform appearance as viewed by Architect from building interior at 5 feet away.
- B. General: In treating historic plaster, disturb it as minimally as possible and as follows unless otherwise indicated:
 - 1. Dismantle loose, damaged, or deteriorated plaster, lath, and support systems that cannot be repaired.
 - 2. Verify extent of plaster deterioration against that indicated on Drawings. Consult Architect on types and extent of required work.
 - 3. Verify that substrate surface conditions are suitable for repairs.
 - 4. Provide lath, furring, and support systems for plaster included in the work of this Section.
 - 5. Replace lost details in new, wet-applied and cast plaster that replicate existing or indicated plaster configurations.
 - 6. Leave repaired plasterwork in proper condition for painting or applying other finishes as indicated.
 - 7. Install temporary protective measures to protect historic surfaces that shall be treated later.
- C. Illumination: Perform plastering work with adequate, uniform illumination that does not distort the flatness or curvature of surfaces.

3.03 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate and environmental conditions, installation tolerances, and other conditions affecting performance of the Work.
 - 1. If existing substrates cannot be prepared to an acceptable condition for plastering work, notify Architect in writing.
 - 2. Notify Architect of undocumented detrimental conditions including cracks, bulges, loose backup, rotted wood, rusted metal, and other deteriorated items.
- B. Masonry Substrates: Verify that mortar joints are struck flush. Notify Architect of undocumented masonry substrate without flush joints. Proceed with plastering as directed by Architect.
- C. Begin historic plastering work only after unsatisfactory conditions have been corrected.

3.04 PREPARATION FOR PLASTERING

- A. Substrates: Prepare according to plaster manufacturer's written instructions and as follows:
 - 1. Clean surfaces to remove dust, loose particles, grease, oil, incompatible curing compounds, form-release agents, and other foreign matter and deposits that could impair bond with plaster.
 - 2. Remove ridges and protrusions greater than 1/8 inch and fill depressions greater than 1/4 inch with patching material. Allow to set and dry.

3.05 PLASTER REMOVAL AND REPLACEMENT, GENERAL

- A. Dismantle plaster that is damaged or deteriorated to the limits indicated. Carefully dismantle areas along straight edges that lie over supports, without damaging surrounding plasterwork.
- B. Maintain lath and supporting members in an undamaged condition so far as practicable. Dismantle damaged lath and supports that cannot be repaired or resecured and replace with new work of same type.
- C. Notify Architect of undocumented detrimental conditions including cracks, bulges, loose backup, rotted wood, rusted metal, and other deteriorated items.
- D. Do not deviate more than plus or minus 1/8 inch in 10 feet from a true plane in finished plaster surfaces, as measured by a 10-foot straightedge placed on surface.

- E. Clean substrate surfaces to remove grease, waxes, oils, waterborne staining, debris, and other foreign matter and deposits that could impair bond with repair material.
- F. Wet masonry bases before plaster application. Keep substrate damp to the touch but without visible water droplets.
- G. Wet remaining plaster abutting the replacement plaster before installing new plasterwork.
- H. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
- I. Provide plaster surfaces that are ready to receive field-applied finishes indicated.

3.06 FLAT GYPSUM-PLASTER REMOVAL AND REPLACEMENT

- A. General: Dismantle deteriorated plaster to existing sound plaster at locations indicated on Drawings. Use replacement plaster mixes of gypsum, lime, and aggregate; and application according to ASTM C842 unless otherwise indicated.
 - 1. Inspect for lath deterioration. If any, replace lath.
 - 2. Sand bonding surfaces of repair area, and clean the surface with a nonmetallic bristle brush.
 - 3. Wet substrate to damp condition, but without visible water droplets, then install new plaster to original profiles.
- B. Bonding Compound: Apply on unit masonry plaster bases.
- C. Gypsum-Plaster Base Coats:
 - 1. Base Coats over Expanded-Metal Lath: High-strength gypsum plaster with job-mixed sand for scratch and brown coats.
 - 2. Base Coats over Unit Masonry: Gypsum lightweight ready-mixed plaster.
- D. Gypsum-Plaster Finish Coats:
 - 1. Finish-Coat Mix for Smooth-Troweled Finishes: Gypsum ready-mixed finish plaster.
- E. Gypsum-Plaster Finishes: .
 - 1. Provide smooth finish, unless notified otherwise.

3.07 CAST-PLASTER REMOVAL AND REPLACEMENT

- A. General: Dismantle and replace cast-plaster that is damaged or deteriorated at locations indicated on Drawings. Carefully dismantle whole cast units from joint to joint, without damaging surrounding plasterwork.
 - 1. Coordinate removal and installation of cast plaster with other plaster repair and installation work.
 - 2. Inspect for deterioration of supporting plaster and lath, and repair or replace deteriorated material as required for a sound substrate.
 - 3. Maintain lath and supporting members in an undamaged condition so far as practicable. Dismantle damaged lath and supports that cannot be repaired or resecured and replace with new work of same type.
 - 4. Sand repair bonding surfaces and clean the surface with a nonmetallic bristle brush.
 - 5. Wetting Substrate: Wet to damp condition, but without visible water droplets.
- B. Replacement Material: Replace cast fabrications in kind or with cast gypsum-plaster fabrications. Replace cast gypsum-plaster fabrications with cast gypsum-plaster fabrications.
- C. Adhering Cast Plaster: Wet the substrate in replacement area and affix cast plaster using finish-coat plaster for smooth-troweled finish as adhesive. Support units until adhesive can fully support weight of plaster. Remove excess adhesive.
- D. Install cast-plaster fabrications level, plumb, true, and aligned with adjacent materials and ready to receive required finishes. Use concealed shims secured with wet plaster where required for alignment.

1. Install replacement, cast-plaster units into bonding and coursing pattern of existing units. Maintain articulated joint widths, if any, between units to match existing joints.
 2. Finish nonarticulated joints with joint-treatment materials so that they are flush or otherwise concealed inconspicuously.
 3. Where cast-plaster units are joined to form composite fabrications, join units inconspicuously and as recommended in writing by manufacturer.
 4. Repair hollows, voids, scratches, and other surface imperfections on units.
- E. Hairline cracking within the plaster or plaster separation at edge of a replacement is unacceptable. Completely dismantle such work and reinstall or repair as a crack repair as directed by Architect.

3.08 REMOVING AND INSTALLING LATH AND ACCESSORIES

- A. General: Dismantle existing plaster as necessary to expose deteriorated or rusted lath, wire ties, and support system, back to firm substrates and supports. Repair with new materials, well secured to existing lath in good condition and to building structure.
1. Cutting: Cut lath so it can be taken out completely from one support to the next. Cut to avoid cracking surrounding plaster.
 2. Cut out existing base-coat plaster beyond the edges of the new lath to permit new plaster to extend onto the old lath. Then step subsequent plaster coats to permit new plaster to extend over the old material.
 3. Fasten new lath to support system and to good existing lath. Wire tie at least every 6 inches.
 4. Install new lath according to ASTM C841 for gypsum plaster.
- B. Notify Architect of undocumented detrimental conditions including cracks, bulges, loose backup, rotted wood, rusted metal, and other deteriorated items.
- C. Wood Lath: Install wood lath in same orientation and spacing as remaining wood lath and with lath ends supported by furring or framing. Stagger ends of adjacent laths over different supports, not aligned, and secure with fasteners at each end and spaced a maximum of 24 inches o.c. into supports.
- D. Metal Lath: Install according to ASTM C841 for gypsum plaster.
1. Partition Framing and Vertical Furring: Install flat diamond-mesh lath.
 2. Flat-Ceiling and Horizontal Framing: Install flat diamond-mesh lath.
 3. Curved-Ceiling Framing: Install flat diamond-mesh lath.
 4. On Solid Surfaces, Not Otherwise Furred: Install self-furring, diamond-mesh lath.

3.09 PATCH-TYPE REPAIR

- A. General: Patch voids, fractured surfaces, and crushed areas in otherwise sound plaster that are larger than cracks at locations indicated on Drawings.
1. Notify Architect of undocumented detrimental conditions including cracks, bulges, loose backup, rotted wood, rusted metal, and other deteriorated items.
 2. Inspect for deterioration of supporting plaster and lath, and repair or replace deteriorated material as required for a sound substrate.
 3. Rake perimeter of hole to sound plaster, and slightly undercut existing plaster to enable replacement plaster to tuck behind existing plaster.
 4. Replace missing lath in kind. Bridge gaps in wood lath with expanded-metal lath, overlapping wood by 6 inches and fastening them together.
 5. Clean hole to remove loose materials and other foreign matter and deposits that could impair bond with repair material. Where grease, waxes, oils, waterborne staining, or other foreign matter and deposits that could impair bond with repair material have penetrated into the plaster, enlarge the hole to remove these deposits.
 6. Wet substrate to damp condition, but without visible water droplets, then install patch material to original profiles.
 7. Maintain adjacent plasterwork in an undamaged condition so far as practicable.
- B. Gypsum-Plaster Mix: Repair mix demonstrated in mockup.

- C. Finishing: Finish flat surfaces flush and with same texture as adjacent existing plaster. For molded plaster shapes, tool surface to restore the sharp edges and the shape of the molded shape to original contours.
- D. Hairline cracking within the plaster or plaster separation at edge of a patch is unacceptable. Completely dismantle such work and reinstall or repair.

3.10 HAIRLINE CRACK REPAIR

- A. General: Repair cracks 1/32 inch in width or narrower in otherwise sound plaster at locations indicated on Drawings.
 - 1. Notify Architect of undocumented detrimental conditions including cracks, bulges, loose backup, rotted wood, rusted metal, and other deteriorated items.
 - 2. Maintain adjacent plasterwork in an undamaged condition so far as practicable.
- B. Existing Topcoat: Open crack in existing topcoat to at least 1/8 inch in width and check for broken fiber reinforcement in base coats.
- C. Existing Base Coats: Do not open crack wider in existing base coats unless inspection or other indication shows that the fiber reinforcement has broken. Where inspections indicate failure of fiber reinforcement, proceed as for a large crack repair, but only for length of crack with broken fiber reinforcement.
- D. Clean out crack to remove loose materials and other foreign matter and deposits that could impair bond with repair material. Where grease, waxes, oils, waterborne staining, or other foreign matter and deposits that could impair bond with repair material have penetrated into the topcoat plaster, widen the crack and sand surface of the exposed basecoat to remove these deposits.
- E. Wet substrate to damp condition, but without visible water droplets.
- F. Force repair material demonstrated in mockup into crack, filling crack to original plaster profile.
- G. Finishing: Finish flat surfaces flush and with same texture as adjacent existing plaster. For molded plaster shapes, tool surface to restore the sharp edges and the shape of the molded shape to original contours.

3.11 LARGE CRACK REPAIR

- A. General: Repair cracks over 1/32 inch in width in otherwise sound plaster at locations indicated on Drawings.
 - 1. Notify Architect of undocumented detrimental conditions including cracks, bulges, loose backup, rotted wood, rusted metal, and other deteriorated items.
 - 2. Maintain adjacent plasterwork in an undamaged condition so far as practicable.
- B. Open crack to at least 1/8 inch in width and full depth with V-groove tool, and check for bond separation or lath deterioration.
- C. Abrade side surfaces of crack and remove inner crack debris by gouging (keying) the inside area of the crack.
- D. Clean out crack to remove loose materials and other foreign matter and deposits that could impair bond with repair material. Where grease, waxes, oils, waterborne staining, or other foreign matter and deposits that could impair bond with repair material have penetrated into the plaster, widen the crack to remove these deposits.
- E. Wet substrate to damp condition, but without visible water droplets.
- F. Install repair material demonstrated in mockup to fill crack to original plaster profile.
- G. Finishing: Finish flat surfaces flush and with same texture as adjacent existing plaster. For molded plaster shapes, tool surface to restore the sharp edges and the shape of the molded shape to original contours.
- H. Offset Cracks: If the crack is offset in surface plane by more than 1/8 inch, dismantle the plaster on each side of the crack, a minimum width of 6 inches and down to the lath or other substrate. Then, repair as specified for flat-plaster removal and replacement.

3.12 REATTACHMENT OF DELAMINATED PLASTER

- A. General: Reattach plaster that has detached from its wooden lath.
 - 1. Notify Architect of undocumented detrimental conditions including cracks, bulges, loose backup, rotted wood, rusted metal, and other deteriorated items.
 - 2. Maintain adjacent plasterwork in an undamaged condition so far as practicable.
- B. Verify extent of detachment of plaster that has not yet fallen by tapping on plaster surface and evaluating the hollow or solid resonance.
- C. Protect floors from spillage and debris in the vicinity of work. Use materials resistant to the passage of fluids used in work.
- D. Drill 1/4-inch injection ports (holes) through the plaster spaced 3 to 6 inches apart over surface of detached plaster. Dislodge loose plaster particles, and vacuum debris from holes.
- E. Prewet injection ports, gaps at edges of lost plaster, back of plaster, and wooden lath with prewet solution.
- F. Inject adhesive into ports, enough to fill gaps between detached plaster and lath, and inject into gaps at edges of lost plaster.
- G. Clean off excess and smeared adhesive while wet.
- H. Apply temporary battens over surface of treated plaster to prevent further separation during repair work. Secure battens in place against plaster with screws through the battens and plaster and into the wood lath.
- I. Maintain temporary battens in place for a week or more, allowing adhesive to coalesce and dry.
- J. Remove battens, patch holes and missing plaster, and repair cracks.

3.13 INSTALLATION TOLERANCES

- A. Completed plaster installation shall not deviate from a true plane by more than 1/8 inch as measured by a 5-foot straightedge placed at any location on a surface, except where existing plaster is retained as a substrate for new plasterwork.

3.14 CLEANING AND PROTECTION

- A. Protect work of other trades against damage. Promptly remove plaster from surfaces not indicated to be repaired or plastered. Do not scratch or damage finished surfaces.
- B. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.
- C. Correct damage to other historic surfaces and to new work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. Remove temporary protection and enclosure of other work.

END OF SECTION 090320

**SECTION 092116
GYPSUM BOARD ASSEMBLIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Performance criteria for gypsum board assemblies.
- B. Metal stud wall framing.
- C. Acoustic insulation.
- D. Cementitious backing board.
- E. Gypsum wallboard.

1.02 RELATED REQUIREMENTS

- A. Section 054000 - Cold-Formed Metal Framing: Structural steel stud framing.
- B. Section 061000 - Rough Carpentry: Wood blocking product and execution requirements.
- C. Section 092216 - Non-Structural Metal Framing.

1.03 REFERENCE STANDARDS

- A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members 2016, with Supplement (2020).
- B. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units 2018.
- C. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units 2019.
- D. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- G. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board 2017 (Reapproved 2022).
- H. ASTM C514 - Standard Specification for Nails for the Application of Gypsum Board 2004 (Reapproved 2020).
- I. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members 2018.
- J. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products 2020.
- K. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board 2020.
- L. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness 2022.
- M. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs 2022.
- N. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base 2019.
- O. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel 2018.
- P. ASTM C1325 - Standard Specification for Fiber-Mat Reinforced Cementitious Backer Units 2022.
- Q. ASTM C1396/C1396M - Standard Specification for Gypsum Board 2017.

- R. ASTM C1658/C1658M - Standard Specification for Glass Mat Gypsum Panels 2019, with Editorial Revision (2020).
- S. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber 2021.
- T. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements 2009 (Reapproved 2016).
- U. ASTM E413 - Classification for Rating Sound Insulation 2022.
- V. GA-216 - Application and Finishing of Gypsum Panel Products 2021.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.
- C. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
- B. Interior Partitions: Provide completed assemblies with the following characteristics:
 - 1. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

2.02 METAL FRAMING MATERIALS

- A. Manufacturers - Metal Framing, Connectors, and Accessories:
 - 1. ClarkDietrich; ____: www.clarkdietrich.com/#sle.
 - 2. Jaimes Industries; ____: www.jaimesind.com/#sle.
 - 3. MarinoWARE; ____: www.marinoware.com/#sle.
 - 4. Phillips Manufacturing Co; ____: www.phillipsmfg.com/#sle.
 - 5. R-stud; ____: www.rstud.com/#sle.
 - 6. SCAFCO Corporation; ____: www.scafco.com/#sle.
 - 7. Steel Construction Systems; ____: www.steelconsystems.com/#sle.
 - 8. Supreme Steel Framing System Association; Supreme Stud: www.ssfsa.com/#sle.
- B. Non-structural Steel Framing for Application of Gypsum Board: See Section 092216.
- C. Non-structural Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf (L/120 at 240 Pa).
 - 1. Studs: C-shaped with knurled or embossed faces.
 - 2. Runners: U shaped, sized to match studs.
 - 3. Furring Members: Hat-shaped sections, minimum depth of 7/8 inch (22 mm).
 - 4. Furring Members: U-shaped sections, minimum depth of 3/4 inch (19.1 mm).
 - 5. Furring Members: Zee-shaped sections, minimum depth of 1 inch (25.4 mm).
- D. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection and prevent rotation of studs while maintaining structural performance of partition.
 - 1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100.
 - 2. Material: ASTM A653/A653M steel sheet, SS Grade 50/340, with G60/Z180 hot-dipped galvanized coating.

2.03 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
 - 1. American Gypsum Company; ____: www.americangypsum.com/#sle.

2. CertainTeed Corporation; ____: www.certainteed.com/#sle.
 3. Georgia-Pacific Gypsum; ____: www.gpgypsum.com/#sle.
 4. Gold Bond Building Products, LLC provided by National Gypsum Company; ____:
www.goldbondbuilding.com/#sle.
 5. PABCO Gypsum; ____: www.pabco gypsum.com/#sle.
 6. USG Corporation; ____: www.usg.com/#sle.
- B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 2. Thickness:
 - a. Vertical Surfaces: 5/8 inch (16 mm).
 3. Paper-Faced Products:
 - a. American Gypsum Company; LightRoc Gypsum Wallboard:
www.americangypsum.com/#sle.
 - b. American Gypsum Company; FireBloc Type X Gypsum Wallboard:
www.americangypsum.com/#sle.
 - c. American Gypsum Company; FireBloc Type C Gypsum Wallboard:
www.americangypsum.com/#sle.
 - d. CertainTeed Corporation; Type C Drywall: www.certainteed.com/#sle.
 - e. CertainTeed Corporation; Type X Drywall: www.certainteed.com/#sle.
 - f. Georgia-Pacific Gypsum; ToughRock: www.gpgypsum.com/#sle.
 - g. Georgia-Pacific Gypsum; ToughRock Fireguard X: www.gpgypsum.com/#sle.
 - h. Georgia-Pacific Gypsum; ToughRock Fireguard C: www.gpgypsum.com/#sle.
 - i. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond Fire-Shield Gypsum Board: www.goldbondbuilding.com/#sle.
 - j. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond Fire-Shield C 5/8" Gypsum Board: www.goldbondbuilding.com/#sle.
 - k. USG Corporation; Sheetrock Brand EcoSmart Panels Firecode X 5/8 in. (15.9 mm):
www.usg.com/#sle.
 - l. USG Corporation; Sheetrock Brand Firecode X Panels 5/8 in. (15.9 mm):
www.usg.com/#sle.
 - m. Substitutions: See Section 016000 - Product Requirements.
- C. Backing Board For Wet Areas: One of the following products:
1. Application: Surfaces behind tile in wet areas including tub and shower surrounds, shower ceilings, and _____.
 2. Application: Horizontal surfaces behind tile in wet areas including countertops and _____.
 3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 4. ANSI Cement-Based Board: Non-gypsum-based; aggregated Portland cement panels with glass fiber mesh embedded in front and back surfaces complying with ANSI A118.9 or ASTM C1325.
 - a. Thickness: 5/8 inch (16 mm).
 5. Glass Mat Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178/C1178M.
 - a. Fire-Resistance-Rated Type: Type X core, thickness 5/8 inch (16 mm).
- D. Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.
1. Application: Vertical surfaces behind thinset tile, except in wet areas.
 2. Type X Thickness: 5/8 inch (16 mm).
 3. Edges: Tapered.

2.04 GYPSUM BOARD ACCESSORIES

- A. Beads, Joint Accessories, and Other Trim: ASTM C1047, rigid plastic, galvanized steel, or rolled zinc, unless noted otherwise.
1. Corner Beads: Low profile, for 90 degree outside corners.

- a. Products:
 - 1) CertainTeed Corporation; No-Coat Drywall Corner: www.certainteed.com/#sle.
 - 2) ClarkDietrich; Strait-Flex Big-Stick: www.clarkdietrich.com/#sle.
2. L-Trim with Tear-Away Strip: Sized to fit 1/2 inch (13 mm) thick gypsum wallboard.
- B. Finishing Compound: Surface coat and primer, takes the place of skim coating.
 1. Products:
 - a. CertainTeed Corporation; Quick Prep Plus Interior Prep Coat: www.certainteed.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- C. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches (0.84 mm) in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.
- D. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch (0.84 to 2.84 mm) in Thickness: ASTM C954; steel drill screws, corrosion-resistant.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.
- B. Studs: Space studs at 16 inches on center (at 406 mm on center).
 1. Extend partition framing to structure where indicated and to ceiling in other locations.
 2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
 3. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
- C. Blocking: Install wood blocking for support of:
 1. Framed openings.
 2. Wall-mounted cabinets.
 3. Plumbing fixtures.
 4. Toilet partitions.
 5. Toilet accessories.
 6. Wall-mounted door hardware.

3.03 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Acoustic Sealant: Install in accordance with manufacturer's instructions.

3.04 BOARD INSTALLATION

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Cementitious Backing Board: Install over steel framing members and plywood substrate where indicated, in accordance with ANSI A108.11 and manufacturer's instructions.

3.05 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet (3 mm in 3 m) in any direction.

END OF SECTION 092116

SECTION 093000 TILING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tile for floor applications.
- B. Tile for wall applications.
- C. Coated glass mat backer board as tile substrate.

1.02 RELATED REQUIREMENTS

- A. Section 035400 - Cast Underlayment.
- B. Section 071400 - Fluid-Applied Waterproofing.
- C. Section 092116 - Gypsum Board Assemblies: Tile backer board.

1.03 REFERENCE STANDARDS

- A. ANSI A108/A118/A136 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium) 2019.
- B. ANSI A108.1a - American National Standard Specifications for Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar 2017.
- C. ANSI A108.1b - American National Standard Specifications for Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar 2017.
- D. ANSI A108.1c - Contractor's Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar 1999 (Reaffirmed 2021).
- E. ANSI A108.2 - American National Standard General Requirements: Materials, Environmental and Workmanship 2019.
- F. ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesive or Water Cleanable Tile-Setting Epoxy Adhesive 2019.
- G. ANSI A108.5 - American National Standard Specifications for Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar 2021.
- H. ANSI A108.6 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grout Epoxy 1999 (Reaffirmed 2019).
- I. ANSI A108.8 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout 1999 (Reaffirmed 2019).
- J. ANSI A108.9 - American National Standard Specifications for Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout 1999 (Reaffirmed 2019).
- K. ANSI A108.10 - American National Standard Specifications for Installation of Grout in Tilework 2017 (Reaffirmed 2022).
- L. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units 2018.
- M. ANSI A108.12 - American National Standard for Installation of Ceramic Tile with EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar 1999 (Reaffirmed 2019).
- N. ANSI A108.13 - American National Standard for Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone 2005 (Reaffirmed 2021).
- O. ANSI A108.19 - American National Standard Specifications for Interior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs by the Thin-Bed Method Bonded with Modified Dry-Set Cement Mortar or Improved Modified Dry-Set Cement Mortar 2020.

- P. ANSI A108.20 - American National Standard Specifications for Exterior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs 2020.
- Q. ANSI A118.4 - American National Standard Specifications for Modified Dry-Set Cement Mortar 2019.
- R. ANSI A118.7 - American National Standard Specifications for High Performance Cement Grouts for Tile Installation 2019.
- S. ANSI A118.12 - American National Standard Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation 2014 (Reaffirmed 2019).
- T. ANSI A118.15 - American National Standard Specifications for Improved Modified Dry-Set Cement Mortar 2019.
- U. ANSI A137.1 - American National Standard Specifications for Ceramic Tile 2022.
- V. ASTM C150/C150M - Standard Specification for Portland Cement 2022.
- W. ASTM C373 - Standard Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products 2018.
- X. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel 2018.
- Y. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation 2022.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by affected installers.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Samples: Mount tile and apply grout on two plywood panels, minimum 18 by 18 inches (457 by 457 mm) in size illustrating pattern, color variations, and grout joint size variations.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Tile: 1 percent of each size, color, and surface finish combination, but not less than 10 sf of each type.

1.06 QUALITY ASSURANCE

- A. Maintain one copy of and ANSI A108/A118/A136 and TCNA (HB) on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum five years of documented experience.
- C. Installer Qualifications: Natural Stone Institute (NSI) Accredited Commercial B Contractor (light commercial): www.naturalstoneinstitute.org/#sle.
- D. Installer Qualifications:
 - 1. Company specializing in performing tile installation, with minimum of five years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Maintain ambient and substrate temperature above 50 degrees F (10 degrees C) and below 100 degrees F (38 degrees C) during installation and curing of setting materials.

PART 2 PRODUCTS

2.01 TILE

- A. Ceramic Mosaic Tile: ANSI A137.1 standard grade.

1. Moisture Absorption: 0 to 0.5 percent as tested in accordance with ASTM C373.
 2. Size: 1 by 1 inch (25 by 25 mm), nominal.
 3. Shape: Hexagon.
 4. Edges: Square.
 5. Surface Finish: Matte glazed.
 6. Color(s): As indicated on drawings.
 7. Trim Units: Matching bead, cove, and surface bullnose shapes in sizes coordinated with field tile.
 8. Products:
 - a. Basis of Design Dal-Tile Corporation; Keystone: www.daltile.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- B. Glazed Wall Tile: ANSI A137.1 standard grade.
1. Size: 3 by 6 inch (76 by 152 mm), nominal.
 2. Edges: Cushioned.
 3. Surface Finish: High gloss.
 4. Color(s): As indicated on drawings.
 5. Trim Units: Matching bead, bullnose, cove, and base shapes in sizes coordinated with field tile.
 6. Products:
 - a. Basis of Design Dal-Tile Corporation; S735 Classic: www.daltile.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- C. Terrazzo Tile:
1. Composition: Portland cement, ASTM C150/C150M; aggregate complying with ASTM C33/C33M.
 2. Size: Match existing terrazzo tile in size and hexagone shape
 3. Surface Finish: Polished.
 4. Color(s): Match existing tiles,
 - a. Aggerate: Match existing size and color
 - b. Cement: Match existing cement color(s)

2.02 SETTING MATERIALS

- A. Provide setting and grout materials from same manufacturer.
- B. Manufacturers:
1. ARDEX Engineered Cements: www.ardexamericas.com/#sle.
 2. Bostik Inc: www.bostik-us.com/#sle.
 3. Custom Building Products: www.custombuildingproducts.com/#sle.
 4. H.B. Fuller Construction Products, Inc: www.tecspecialty.com/#sle.
 5. LATICRETE International, Inc: www.laticrete.com/#sle.
 6. Substitutions: See Section 016000 - Product Requirements.
- C. Improved Latex-Portland Cement Mortar Bond Coat: ANSI A118.15.
1. Applications: Use this type of bond coat where Large and Heavy Tile (LHT) mortar is indicated.
 2. Products:
 - a. ARDEX Engineered Cements; S 28: www.ardexamericas.com/#sle.
 - b. Custom Building Products; Complete Contact-LFT Premium Rapid Setting Large Format Tile Mortar, with Multi-Surface Bonding Primer: www.custombuildingproducts.com/#sle.
 - c. H.B. Fuller Construction Products, Inc; TEC TotalFlex 150 Universal Mortar: www.tecspecialty.com/#sle.
 - d. LATICRETE International, Inc; MULTIMAX LITE: www.laticrete.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.

2.03 GROUTS

- A. Provide setting and grout materials from same manufacturer.

- B. High Performance Polymer Modified Grout: ANSI A118.7 polymer modified cement grout.
 - 1. Applications: Use this type of grout where indicated and where no other type of grout is indicated.
 - 2. Use sanded grout for joints 1/8 inch (3.2 mm) wide and larger; use unsanded grout for joints less than 1/8 inch (3.2 mm) wide.
 - 3. Color(s): Match existing grout colors

2.04 MAINTENANCE MATERIALS

- A. Tile Sealant: Gunnable, silicone, siliconized acrylic, or urethane sealant; moisture and mildew resistant type.
 - 1. Applications: Between tile and plumbing fixtures.
 - 2. Color(s): Match adjacent tile colors. At plumbing fixtures use white..
 - 3. Products:
 - a. ARDEX Engineered Cements; ARDEX SX: www.ardexamericas.com/#sle.
 - b. Custom Building Products; Commercial 100% Silicone Caulk: www.custombuildingproducts.com/#sle.
 - c. LATICRETE International, Inc; LATICRETE LATASIL: www.laticrete.com/#sle.
- B. Grout Sealer: Liquid-applied, moisture and stain protection for existing or new Portland cement grout.
 - 1. Composition: Water-based colorless silicone.

2.05 ACCESSORY MATERIALS

- A. Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.12; not intended as waterproofing.
 - 1. Crack Resistance: No failure at 1/8 inch (3.2 mm) gap, minimum.
 - 2. Fluid or Trowel Applied Type:
 - a. Material: Synthetic rubber or Acrylic.
 - b. Thickness: 20 mils (0.5 mm), maximum.
 - c. Products:
 - 1) H.B. Fuller Construction Products, Inc; TEC HydraFlex Waterproofing Crack Isolation Membrane: www.tecspecialty.com/#sle.
 - 2) LATICRETE International, Inc; LATICRETE Blue 92 Anti-Fracture Membrane: www.laticrete.com/#sle.
 - 3) Merkrete, by Parex USA, Inc; Merkrete Fracture Guard: www.merkrete.com/#sle.
 - 4) Sika Corp; SikaTile 200 Fracture Guard Rapid: www.sika.com/#sle.
- B. Backer Board: Coated glass mat type complying with ASTM C1178/C1178M; inorganic fiberglass mat on both surfaces and integral acrylic coating vapor retarder.
- C. Mesh Tape: 2 inch (50 mm) wide self-adhesive fiberglass mesh tape.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that subfloor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.

3.02 PREPARATION

- A. Protect surrounding work from damage.
- B. Vacuum clean surfaces and damp clean.
- C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.
- D. Install backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of setting material to a feather edge.

3.03 INSTALLATION - GENERAL

- A. Install tile, thresholds, and stair treads and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.20, manufacturer's instructions, and TCNA (HB) recommendations.
- B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
- C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
- D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
- E. Form internal angles square and external angles bullnosed.
- F. Sound tile after setting. Replace hollow sounding units.
- G. Keep control and expansion joints free of mortar, grout, and adhesive.
- H. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- I. Grout tile joints unless otherwise indicated. Use standard grout unless otherwise indicated.
- J. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS

- A. Over interior concrete substrates, install in accordance with TCNA (HB) Method F113, dry-set or latex-Portland cement bond coat, with standard grout, unless otherwise indicated.
 - 1. Where waterproofing membrane is indicated, install in accordance with TCNA (HB) Method F122, with latex-Portland cement grout.

3.05 INSTALLATION - FLOORS - MORTAR BED METHODS

- A. Over interior concrete substrates, install in accordance with TCNA (HB) Method F111, with cleavage membrane, unless otherwise indicated.
- B. Cleavage Membrane: Lap edges and ends.
- C. Mortar Bed Thickness: 5/8 inch (15.9 mm), unless otherwise indicated.

3.06 INSTALLATION - WALL TILE

- A. Over coated glass mat backer board on studs, install in accordance with TCNA (HB) Method W245.

3.07 CLEANING

- A. Clean tile and grout surfaces.

3.08 PROTECTION

- A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION 093000

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SECTION 095100 ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units.

1.02 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- C. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings 2022.
- D. ASTM E1264 - Standard Classification for Acoustical Ceiling Products 2022.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Samples: Submit two samples 6" by 6" inch (152 by 152 mm) in size illustrating material and finish of acoustical units.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acoustic Tiles/Panels:
 - 1. Armstrong World Industries, Inc; ____: www.armstrongceilings.com/#sle.
 - 2. CertainTeed Corporation; ____: www.certainteed.com/ceilings-and-walls/#sle.
 - 3. Rockfon; ____: www.rockfon.com/#sle.
 - 4. USG Corporation; ____: www.usg.com/ceilings/#sle.
- B. Suspension Systems:
 - 1. Same as for acoustical units.

2.02 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Ceiling systems designed to withstand the effects of earthquake motions determined according to ASCE 7 for Seismic Design Category D, E, or F and complying with the following:

2.03 ACOUSTICAL UNITS

- A. Acoustical Units - General: ASTM E1264, Class A.
- B. Acoustical Panels, Type ____: Painted mineral fiber, with the following characteristics:
 - 1. Classification: ASTM E1264 Type III.
 - 2. Size: 24 by 24 inches (610 by 610 mm).
 - 3. Thickness: 3/4 inch (19 mm).
 - 4. Panel Edge: Square.
 - 5. Suspension System: Exposed grid.
- C. Acoustical Panels, Type ____: Mineral fiber with membrane-faced overlay, with the following characteristics:
 - 1. Classification: ASTM E1264 Type IV.
 - 2. Size: 24 by 24 inches (610 by 610 mm).
 - 3. Thickness: 3/4 inch (19 mm).

4. Panel Edge: Square.
5. Suspension System: Exposed grid.

2.04 SUSPENSION SYSTEM(S)

- A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.
- B. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.
 1. Materials:
 - a. Steel Grid: ASTM A653/A653M, G30 coating, unless otherwise indicated.
- C. Exposed Suspension System, Type ____: Hot-dipped galvanized steel grid with steel cap.
 1. Application(s): Seismic.
 2. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
 3. Profile: Tee; 15/16 inch (24 mm) face width.
 4. Finish: Baked enamel.
 5. Color: White.

2.05 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- B. Hanger Wire: 12 gauge, 0.08 inch (2 mm) galvanized steel wire.
- C. Seismic Clips: Manufacturer's standard clips for seismic conditions and to suit application.
- D. Perimeter Moldings: Same metal and finish as grid.
 1. Angle Molding: L-shaped, for mounting at same elevation as face of grid.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.02 INSTALLATION - SUSPENSION SYSTEM

- A. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- B. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 1. Use longest practical lengths.
- C. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- D. Seismic Suspension System, Seismic Design Categories D, E, F: Hang suspension system with grid ends attached to the perimeter molding on two adjacent walls; on opposite walls, maintain a 3/4 inch (19 mm) clearance between grid ends and wall.
- E. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- F. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- G. Support fixture loads using supplementary hangers located within 6 inches (152 mm) of each corner, or support components independently.
- H. Do not eccentrically load system or induce rotation of runners.

3.03 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Fit border trim neatly against abutting surfaces.
- D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- E. Cutting Acoustical Units:
 - 1. Make field cut edges of same profile as factory edges.

3.04 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet (3 mm in 3 m).
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.05 CLEANING

- A. Clean surfaces.
- B. Replace damaged or abraded components.

END OF SECTION 095100

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**SECTION 096500
RESILIENT FLOORING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Resilient tile flooring.
- B. Resilient stair accessories.

1.02 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding for Electrical Systems: Grounding and bonding of static control flooring to building grounding system.

1.03 REFERENCE STANDARDS

- A. ASTM D6329 - Standard Guide for Developing Methodology for Evaluating the Ability of Indoor Materials to Support Microbial Growth Using Static Environmental Chambers 1998 (Reapproved 2023).
- B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source 2019a, with Editorial Revision (2020).
- C. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring 2021.
- D. ASTM F1066 - Standard Specification for Vinyl Composition Floor Tile 2004 (Reapproved 2018).
- E. ASTM F1700 - Standard Specification for Solid Vinyl Floor Tile 2020.
- F. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride 2022.
- G. ASTM F2169 - Standard Specification for Resilient Stair Treads 2015 (Reapproved 2020).
- H. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes 2019a.
- I. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source 2023.
- J. RFCI (RWP) - Recommended Work Practices for Removal of Resilient Floor Coverings 2011.
- K. UL 2824 - GREENGUARD Certification Program Method for Measuring Microbial Resistance From Various Sources Using Static Environmental Chambers Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial selection.
- D. Verification Samples: Submit two full sized samples for each resilient flooring product specified.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Flooring Material: 10 square feet (0.93 square meters) of each type and color.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.
- B. Store all materials off of the floor in an acclimatized, weather-tight space.

1.06 FIELD CONDITIONS

- A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F (21 degrees C) to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F (13 degrees C).

PART 2 PRODUCTS

2.01 TILE FLOORING

- A. Vinyl Tile: Solid vinyl with color and pattern throughout thickness.
 - 1. Manufacturers:
 - a. Armstrong Flooring: www.armstrongflooring.com/#sle.
 - b. Flexco Corporation: www.flexcofloors.com/#sle.
 - c. Johnsonite, a Tarkett Company: www.johnsonite.com/#sle.
 - d. Mannington Commercial: www.manningtoncommercial.com/#sle.
 - e. Roppe Corporation: www.roppe.com/#sle.
 - f. Tarkett Company: <https://commercial.tarkett.com/>
 - g. Substitutions: See Section 016000 - Product Requirements.
 - 2. Minimum Requirements: Comply with ASTM F1700, of Class corresponding to type specified.
 - 3. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 - 4. Mold and Microbial Resistance: Highly resistant when tested in accordance with ASTM D6329; certified in accordance with UL 2824.
 - 5. Square Tile Size: 12 by 12 inch (305 by 305 mm).
 - 6. Total Thickness: 0.125 inch (3 mm).
 - 7. Color: As indicated on drawings.

2.02 STAIR COVERING

- A. Stair Treads: Vinyl; full width and depth of stair tread in one piece; tapered thickness.
 - 1. Manufacturers:
 - a. Johnsonite, a Tarkett Company; _____: www.johnsonite.com/#sle.
 - b. Mannington Commercial; _____: www.manningtoncommercial.com/#sle.
 - c. Roppe Corporation; Rubber Stair Treads: www.roppe.com/#sle.
 - 2. Minimum Requirements: Comply with ASTM F2169, Type TV, vinyl, thermoplastic.
 - 3. Nosing: Square.
 - 4. Color: As indicated on drawings.
- B. Stair Nosings: 1-1/2 inch (38 mm) horizontal return, 1-1/8 inch (28.5 mm) vertical return, full width of stair tread in one piece.
 - 1. Manufacturers:
 - a. Johnsonite, a Tarkett Company; _____: www.johnsonite.com/#sle.
 - b. Mannington Commercial; _____: www.manningtoncommercial.com/#sle.
 - c. Roppe Corporation; _____: www.roppe.com/#sle.
 - 2. Material: Vinyl.
 - 3. Nominal Thickness: 0.125 inch (3.2 mm).
 - 4. Color: As shown on drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).
 - 1. Test as Follows:
 - a. Alkalinity (pH): ASTM F710.

- b. Internal Relative Humidity: ASTM F2170.
 - c. Moisture Vapor Emission: ASTM F1869.
2. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

3.02 PREPARATION

- A. Remove existing resilient flooring and flooring adhesives; follow the recommendations of RFCI (RWP).
- B. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- C. Remove subfloor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor filler to achieve smooth, flat, hard surface.
- D. Prohibit traffic until filler is fully cured.
- E. Clean substrate.

3.03 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install in accordance with manufacturer's written instructions.
- C. Adhesive-Applied Installation:
 1. Spread only enough adhesive to permit installation of materials before initial set.
 2. Place copper grounding strip in conductive adhesive and apply additional adhesive to top side of strip before installing static control flooring. Allow strip to extend beyond flooring in accordance with static control flooring manufacturer's instructions. Refer to Section 260526 for grounding and bonding to building grounding system.
 3. Fit joints and butt seams tightly.
 4. Set flooring in place, press with heavy roller to attain full adhesion.
- D. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
 1. Resilient Strips: Attach to substrate using adhesive.
- E. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.04 INSTALLATION - TILE FLOORING

- A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.
- B. Lay flooring with joints and seams parallel to building lines to produce symmetrical pattern.

3.05 INSTALLATION - STAIR COVERINGS

- A. Adhere over entire surface. Fit accurately and securely.

3.06 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's written instructions.

3.07 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION 096500

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**SECTION 096613
PORTLAND CEMENT TERRAZZO FLOORING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cast-in-place terrazzo floor.
- B. Divider strips and termination edging.
- C. Precast Portland cement terrazzo units.

1.02 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete subfloor with wood float finish.
- B. Section 079200 - Joint Sealants: Sealing joints between terrazzo work and adjacent construction and fixtures.

1.03 REFERENCE STANDARDS

- A. ANSI A118.4 - American National Standard Specifications for Modified Dry-Set Cement Mortar 2019.
- B. ASTM C33/C33M - Standard Specification for Concrete Aggregates 2018.
- C. ASTM C150/C150M - Standard Specification for Portland Cement 2022.
- D. ICRI 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair 2013.
- E. NTMA (SPECS) - NTMA Terrazzo Specifications Current Edition.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Samples:
 - 1. Submit two samples, 6 by 6 inch (150 by 150 mm) in size illustrating color, chip size and variation, chip gradation, mortar color, and typical divider strip.
 - 2. Submit full sized sample of each custom tile for size verification, color and thickness.
- C. Cleaning and Maintenance Data: Include procedures for stain removal, stripping, and sealing.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with NTMA recommendations as posted on their web site at www.ntma.com.

1.06 MOCK-UP

- A. Construct mock-up of terrazzo flooring illustrating appearance of finished work. Size mock-up to be not less than 3 by 3 feet (1 by 1 m).
- B. Mock-up may remain as part of the Work.

1.07 FIELD CONDITIONS

- A. Do not install terrazzo when temperature is below 50 degrees F (10 degrees C) or above 90 degrees F (32 degrees C).
- B. Maintain temperature within specified range 24 hours before, during, and 72 hours after installation of terrazzo.

PART 2 PRODUCTS

2.01 PORTLAND CEMENT TERRAZZO FLOORING

- A. Materials:
 - 1. Portland Cement: ASTM C150/C150M, Type I Normal; white color for topping mix; modified to NTMA higher compressive strength requirements; obtained from single source.
 - 2. Color Pigments For Topping: Non-fading mineral type to match historic terrazzo topping mix color, alkali-resistant.

3. Terrazzo Sand: ASTM C33/C33M fine aggregates.
 4. Water: Potable.
 5. Surface Aggregate: Marble, free of deleterious or foreign matter To match color, size, appearance of historic terrazzo..
- B. Accessories: Match existing look. Terrazzo may be scored in lieu of divider strips.
1. Divider Strips: 1/8 inch (3 mm) thick zinc exposed top strip, zinc coated steel concealed bottom strip, with anchoring features. Color and material selected from manufacturer's full range.
 2. Divider and Control Joint Strip Height: To suit thickness of terrazzo topping, with allowance for grinding.
 3. Cleaner: Neutralizing liquid type, pH of 7 to 10.
 4. Sealer: Colorless, non-yellowing, penetrating liquid type, pH of 7 to 10; not detrimental to terrazzo components.

2.02 PRECAST PORTLAND CEMENT TERRAZZO UNITS

- A. Precast Portland Cement Terrazzo Units: Portland cement matrix, ASTM C150/C150M; cleaned and graded aggregate sized in accordance with NTMA gradation standards.
1. Fabricate to sizes and profiles to match existing.
 2. Setting Material: Latex Portland cement mortar, ANSI A118.4.
 3. Anchors and Reinforcement for Precast Units: As recommended by manufacturer for type of installation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.

3.02 PREPARATION

- A. Clean substrate of foreign matter.

3.03 APPLICATION - MONOLITHIC TERRAZZO

- A. Saw cut existing floor slab to receive divider and control joint strips and inserts and fill with grout.
- B. Install strips straight and level to locations indicated.
- C. Place terrazzo topping mix over slurry coated substrate to a nominal thickness of 1/2 inch (12 mm).

3.04 CURING

- A. Begin curing procedures as soon as curing materials can be applied without damaging formed surfaces.
- B. Close area to construction traffic, allowing undisturbed curing.

3.05 INSTALLATION - PRECAST PORTLAND CEMENT TERRAZZO UNITS

- A. Anchor precast units as shown on drawings.
- B. Install precast units using specified setting material.

3.06 SURFACE FINISHING

- A. Brush apply terrazzo topping mix slurry to topping surface.
- B. Finish terrazzo in accordance with NTMA instructions.
- C. Grind terrazzo surface with power disc machine; successively sequence using coarse to fine grit abrasive, using a wet method.
- D. Apply grout mix matching matrix color to fill honeycomb exposed during grinding.
- E. After grout has sufficiently cured, grind repaired areas using a fine grit abrasive.

3.07 CLEANING

- A. Scrub and clean terrazzo surfaces with cleaner in accordance with NTMA instructions. Let dry.

- B. Seal and polish surfaces in accordance with NTMA instructions.

3.08 PROTECTION

- A. Do not permit construction traffic over finished terrazzo surfaces.

END OF SECTION 096613

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SECTION 097500 STONE FACING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Independently supported stone veneer at interior walls.
- B. Grout.
- C. Mortar.

1.02 RELATED REQUIREMENTS

- A. Section 040511 - Masonry Mortaring and Grouting: Setting mortar.
- B. Section 079200 - Joint Sealants: Sealing joints indicated to be left open for sealant.

1.03 REFERENCE STANDARDS

- A. ANSI A108.2 - American National Standard General Requirements: Materials, Environmental and Workmanship 2019.
- B. ANSI A118.6 - American National Standard Specifications for Standard Cement Grouts for Tile Installation 2019.
- C. ASTM A580/A580M - Standard Specification for Stainless Steel Wire 2018.
- D. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2022.
- E. ASTM C119 - Standard Terminology Relating to Dimension Stone 2022.
- F. ASTM C503/C503M - Standard Specification for Marble Dimension Stone 2015.
- G. ASTM C1528/C1528M - Standard Guide for Selection of Dimension Stone 2020.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section; require attendance by affected installers.
 - 1. Coordinate items that attach to or penetrate the affected walls.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for stone units, anchor accessories, adhesives, grout, mortar, and reinforcement.
- C. Shop Drawings:
 - 1. Submit plans, elevations, and sections:
 - a. Indicate courses for patterns, cutout locations and sizes, and joint widths; and details for corners, door headers, door sills, and jambs.
 - b. Indicate direction of grain pattern. Match existing
- D. Samples: Submit two stone samples of each stone type, indicating minimum and maximum stone sizes, color range, texture, and markings.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect stone from discoloration during storage on site.
- B. Provide ventilation to prevent condensation from forming on stone.
- C. Store stone off the ground and under cover. Store stone panels vertically on edge, resting weight on panel edge.
- D. Protect materials during handling and installation to prevent damage or contamination.
- E. Store dry materials off ground and under shelter from water.
- F. Store liquid materials off ground and covered.
- G. Protect liquid materials from freezing.

PART 2 PRODUCTS

2.01 STONE

- A. Stone, General: See recommendations in ASTM C1528/C1528M.
- B. Marble: _____ variety; complying with ASTM C503/C503M Classification I - Calcite. See finish schedule AE165.
 - 1. Color: W1: Light Rose to match existing. W2: Tennessee Cedar to match existing..
 - 2. Surface Finish: Polished; as described in ASTM C119 and ASTM C1528/C1528M.

2.02 MORTAR

- A. At Contractor's option, mortar may be field-mixed from packaged dry materials, made from factory premixed dry materials with addition of water only, or ready-mixed.
- B. Mortar Color: Natural gray unless otherwise indicated.
- C. Mortar Bed Accessories:
 - 1. Portland Cement Mortar Thickset Installation Materials: ANSI A108.2.
 - a. Welded Wire Reinforcement: Galvanized, welded wire, comply with ASTM A1064/A1064M, except for minimum wire size.
 - 1) Minimum Wire Size: 2 by 2 inches by 0.062 inch diameter (20.8 by 50.8 mm 1.27 mm diameter).
 - 2) Base Metal and Finish: Galvanized steel sheet.
 - 3) Weight: 2.5 lbs/sq yd (1.13 kg/sq m).

2.03 GROUT

- A. Provide setting and grout materials from same manufacturer.
- B. Standard Grout: ANSI A118.6 standard cement grout.
 - 1. Applications: Use this type of grout where indicated and where no other type of grout is indicated.
 - 2. Use sanded grout for joints.
 - 3. Color(s): As selected by Architect from manufacturer's full line. The intent is to match existing.

2.04 STONE ANCHORS AND ATTACHMENTS

- A. Provide anchors and attachments of type and size required to support stonework.

2.05 STONE FABRICATION

- A. Independently supported Stone Veneer:
 - 1. Nominal Thickness: 3/4 inches (2 cm).

2.06 ACCESSORIES

- A. Wall Ties: Formed steel wire, at least ____ inch (____ mm) diameter, stainless steel complying with ASTM A580/A580M, eye and pintle type and wall strap for screw attachment to studs, with provision for vertical adjustment after attachment.
- B. Cleaning Solution: Type that will not harm stone, joint materials, or adjacent surfaces.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that support work and site conditions are ready to receive work of this section.
- B. Verify that substrates to receive mortar scratch coat or setting bed comply with stone veneer manufacturer's instructions.

3.02 INDEPENDENTLY SUPPORTED STONE VENEER

- A. Preparation:
 - 1. Establish lines, levels, and courses. Protect from disturbance.
- B. Installation:
 - 1. Size stone units to fit opening dimensions and perimeter conditions.

2. Arrange stone coursing with consistent joint width.
- C. Reinforcement and Anchorage:
 1. Place wall ties at maximum 3 inches (75 mm) on center each way around perimeter of openings, within 12 inches (300 mm) of openings.
- D. Joints:
 1. Leave the following joints open for sealant specified in Section 079200:
 - a. Joints in projecting units.
 - b. Joints below lugged sills and stair treads.
 - c. Joints below ledge and relieving angles.
 - d. Joints labeled "expansion joint."
 2. Pack mortar into joints and work into voids. Neatly tool surface to concave joint.
 3. At joints to be sealed, clean mortar out of joint before it sets. Brush joints clean.

3.03 CLEANING

- A. Remove excess mortar as work progresses and upon completion of work.
- B. Clean soiled surfaces with cleaning solution.
- C. Use nonmetallic tools in cleaning operations.

END OF SECTION 097500

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**SECTION 099123
INTERIOR PAINTING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints.
- C. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.
- D. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
 - 5. Floors, unless specifically indicated.
 - 6. Glass.
 - 7. Concealed pipes, ducts, and conduits.

1.02 REFERENCE STANDARDS

- A. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials 2020.
- B. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual Current Edition.
- C. SSPC-SP 6 - Commercial Blast Cleaning 2007.
- D. SSPC-SP 13 - Surface Preparation of Concrete 2018.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Samples: Submit two paper chip samples, 8.5 X 11 inch (215.9 x 279.4 mm) in size illustrating range of colors and textures available for each surface finishing product scheduled.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.05 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Provide lighting level of 80 ft candles (860 lx) measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.

- B. Paints:
 - 1. Base Manufacturer: Sherwin-Williams.
- C. Primer Sealers:
 - 1. Same manufacturer as top coats.
 - 2. Stix Waterborne Bonding Primer Primer (SXA-110)
- D. Substitutions: See Section 016000 - Product Requirements.

2.02 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready-mixed, unless intended to be a field-catalyzed paint.
 - 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Supply each paint material in quantity required to complete entire project's work from a single production run.
 - 3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B. Colors: As indicated on drawings.
 - 1. Selection to be made by Architect after award of contract.

2.03 PAINT SYSTEMS - INTERIOR

- A. Paint I-OP - Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board, concrete, wood, plaster, and GFRG. Paint will only occur behind abandoned windows indicated in drawings. Prime gypsum board, GRFG and wood as indicated in the drawings.
 - 1. Two top coats and one coat primer.
 - 2. Top Coat(s): Institutional Low Odor/VOC Interior Latex; MPI #143, 144, 145, 146, 147, or 148.

2.04 PRIMERS

- A. Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.
 - 1. Bonding Primer, Water Based; MPI #17. Recommended for GFRG castings.
 - a. Products:
 - 1) Kilz Adhesion Bonding Primer [No. L2111].

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin application of paints and finishes until substrates have been adequately prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- D. Test shop-applied primer for compatibility with subsequent cover materials.
- E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
 - 1. Gypsum Wallboard: 12 percent.
 - 2. Plaster and Stucco: 12 percent.
 - 3. Masonry, Concrete, and Concrete Masonry Units: 12 percent.
 - 4. Interior Wood: 15 percent, measured in accordance with ASTM D4442.
 - 5. Concrete Floors and Traffic Surfaces: 8 percent.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Concrete:
 - 1. Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
 - 2. Prepare surface as recommended by top coat manufacturer and according to SSPC-SP 13.
- F. Concrete Floors and Traffic Surfaces: Remove contamination, acid etch and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.
- G. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
- H. Plaster: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.
- I. Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.

3.03 APPLICATION

- A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- C. Apply each coat to uniform appearance in thicknesses specified by manufacturer.
- D. Sand wood and metal surfaces lightly between coats to achieve required finish.
- E. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- F. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.05 PROTECTION

- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 099123

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**SECTION 099300
STAINING AND TRANSPARENT FINISHING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of stains and transparent finishes.

1.02 REFERENCE STANDARDS

- A. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual Current Edition.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Samples: Submit two samples, illustrating selected colors and sheens for each system with specified coats cascaded. Match existing wood finish. Submit on actual wood substrate to be finished, 12 x12 inch (____x____ mm) in size.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of stain or transparent finish, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Stain and Transparent Finish Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.05 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by manufacturer of stains and transparent finishes.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide finishes from the same manufacturer to the greatest extent possible.
 - 1. In the event that a single manufacturer cannot provide specified products, minor exceptions will be permitted provided approval by Architect is obtained using the specified procedures for substitutions.
- B. Transparent Finishes:
 - 1. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- C. Stains:
 - 1. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.02 STAINS AND TRANSPARENT FINISHES - GENERAL

- A. Finishes:
 - 1. Provide finishes capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

3. Supply each finish material in quantity required to complete entire project's work from a single production run.
4. Do not reduce, thin, or dilute finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.

2.03 INTERIOR STAIN AND TRANSPARENT FINISH SYSTEMS

- A. Finish on Wood - Vertical Surfaces: Match existing stain and finish.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin application of stains and finishes until substrates have been properly prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially effect proper application.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or repair existing finishes that exhibit surface defects.
- D. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- E. Seal surfaces that might cause bleed through or staining of topcoat.
- F. Wood Surfaces to Receive Transparent Finish: Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats. Prime concealed surfaces with gloss varnish reduced 25 percent with thinner.

3.03 APPLICATION

- A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- C. Apply each coat to uniform appearance in thicknesses specified by manufacturer.
- D. Sand wood surfaces lightly between coats to achieve required finish.
- E. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- F. Wood to Receive Transparent Finishes: Tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
- G. Reinstall items removed prior to finishing.

3.04 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.05 PROTECTION

- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 099300

**SECTION 099723
CONCRETE AND MASONRY COATINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Moisture resistant smooth concrete and masonry coatings.

1.02 REFERENCE STANDARDS

- A. ASTM D968 - Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive 2022.
- B. SSPC-SP 2 - Hand Tool Cleaning 2018.
- C. SSPC-SP 3 - Power Tool Cleaning 2018.
- D. SSPC-SP 6 - Commercial Blast Cleaning 2007.
- E. SSPC-SP 7 - Brush-Off Blast Cleaning 2007.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating coating materials and _____.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.04 FIELD CONDITIONS

- A. Do not install materials when temperature is below 55 degrees F (13 degrees C) or above 90 degrees F (32 degrees C).
- B. Maintain this temperature range, 24 hours before, during, and 72 hours after installation of coating.
- C. Restrict traffic from area where coating is being applied or is curing.

1.05 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Warranty: Include coverage for bond to substrate.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Coatings - General: Provide complete systems formulated and recommended by manufacturer for the applications indicated, in the thicknesses indicated.
- B. Water Based, Silicone-Modified Acrylic Coating:
 - 1. Dry Film Thickness: 14 mils, 0.014 inch (0.356 mm), minimum.
 - 2. Color: Clear.
 - 3. Manufacturers, not limited to:
 - a. Master Builders Solutions; MasterProtect EL 850: www.master-builders-solutions.com/en-us/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that substrate surfaces are ready to receive work as instructed by the coating manufacturer. Obtain and follow manufacturer's instructions for examination and testing of substrates.
- C. Cementitious Substrates: Do not begin application until substrate has cured 28 days minimum and measured moisture content is not greater than 16 percent.

3.02 PREPARATION

- A. Clean surfaces of loose foreign matter.

- B. Remove substances that would bleed through finished coatings.
- C. Remove finish hardware, fixture covers, and accessories and store.
- D. Existing Painted and Sealed Surfaces:
 - 1. Clean with mixture of trisodium phosphate and water to remove surface grease and foreign matter.
- E. Protect adjacent surfaces and materials not receiving coating from spatter and overspray; mask if necessary to provide adequate protection. Repair damage.

3.03 PRIMING

- A. Apply primer to all surfaces, unless specifically not required by coating manufacturer. Apply in accordance with coating manufacturer's instructions.
- B. Concrete and Masonry: Prior to priming, patch holes and indentations and fill cracks with manufacturer's recommended crack repair material.

3.04 COATING APPLICATION

- A. Apply coatings in accordance with manufacturer's instructions, to thicknesses specified.
- B. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

3.05 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.
- B. Clean surfaces immediately of overspray, splatter, and excess material.
- C. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

3.06 PROTECTION

- A. Protect finished work from damage.

END OF SECTION 099723

SECTION 101423 PANEL SIGNAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Panel signage.

1.02 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- B. ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's product literature for each type of panel sign, indicating styles, font, foreground and background colors, locations, and overall dimensions of each sign.
- C. Shop Drawings:
 - 1. Include dimensions, locations, elevations, materials, text and graphic layout, attachment details, and schedules.
- D. Selection Samples: Where colors, materials, and finishes are not specified, submit two sets of color selection charts or chips.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Package signs as required to prevent damage before installation.
- B. Package room and door signs in sequential order of installation, labeled by floor or building.
- C. Store under cover and elevated above grade.
- D. Store tape adhesive at normal room temperature.

1.05 FIELD CONDITIONS

- A. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer.
- B. Maintain minimum ambient temperature during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Panel Signage:
 - 1. Best Sign Systems, Inc; Strata: www.bestsigns.com/#sle.
 - 2. Mohawk Sign Systems, Inc; 1000 ADA: www.mohawksign.com/#sle.
 - 3. Vista System LLC; Nova Family: www.vistasystem.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.

2.02 REGULATORY REQUIREMENTS

- A. Accessibility Requirements: Comply with ADA Standards and ICC A117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most restrictive requirements.

2.03 PANEL SIGNAGE

- A. Panel Signage:
 - 1. Application: Room and door signs.
 - 2. Description: Flat signs with engraved panel media, tactile characters.
 - 3. Sign Size: As indicated on drawings.
 - 4. Total Thickness: 1/8 inch (3 mm).
 - 5. Color and Font, unless otherwise indicated:
 - a. Character Font: Helvetica, Arial, or other sans serif font.
 - b. Character Case: Upper and lower case (title case).

- c. Background Color: Architect to select from manufacturers full range..
- d. Character Color: Contrasting color.
- 6. Material: Laminated colored plastic engraved through face to expose core as background color.
- 7. Profile: Flat panel in aluminum frame.
 - a. Frame Finish: Black anodized.
- 8. Tactile Letters: Raised 1/32 inch minimum.
- 9. Braille: Grade II, ADA-compliant.

2.04 SIGNAGE APPLICATIONS

- A. Room and Door Signs:
 - 1. Rest Rooms: Identify with pictograms, the names "MEN" and "WOMEN", and braille.

2.05 ACCESSORIES

- A. Concealed Screws: Noncorroding metal; stainless steel, galvanized steel, chrome plated, or other.
- B. Tape Adhesive: Double-sided tape, permanent adhesive.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.
- B. Notify Architect if conditions are not suitable for installation of signs; do not proceed until conditions are satisfactory.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install with horizontal edges level.
- C. Locate panel signs and mount at heights indicated on drawings and in accordance with ADA Standards and ICC A117.1.
- D. Protect from damage until substantial completion; repair or replace damaged items.

END OF SECTION 101423

**SECTION 102113.13
METAL TOILET COMPARTMENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal toilet compartments.
- B. Urinal screens.

1.02 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry: Blocking and supports.
- B. Section 102800 - Toilet, Bath, and Laundry Accessories.

1.03 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI):
- B. ANSI/ICC A117.1 - Accessible and Usable Buildings and Facilities.

1.04 ASTM INTERNATIONAL:

- A. ASTM A424/A424M - Standard Specification for Steel, Sheet, for Porcelain Enameling 2018.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work with placement of support framing and anchors in walls and ceilings.

1.06 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall, floor, and ceiling supports, door swings, and installation of compartment assemblies that are not fully described by architectural drawings.
- C. Provide template layouts and installation instructions for anchorage devices built into other work.
- D. Product Data: Provide Manufacturers product data for materials, fabrication, and installation including catalog cuts of anchors, hardware, fastenings, and accessories, including: 1. Preparation instructions and recommendations. 2. Storage and handling requirements and recommendations. 3. Installation methods.
- E. Samples: Submit two samples of partition panels, 2 x 3.5 inch (50.8 x 88.9 mm) in size illustrating panel finish, color, and sheen.
- F. Manufacturer's Installation Instructions: Indicate special procedures.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Metal Toilet Compartments:
 - 1. ASI Global Partitions; Stainless Steel: www.asi-globalpartitions.com/#sle.
 - 2. Metpar Corp; DUR-A-TEX: www.metpar.com/#sle.
 - 3. Substitutions: Section 016000 - Product Requirements.

2.02 MATERIALS

- A. MATERIALS
 - 1. Steel Sheet: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.
 - 2. Steel Sheet: ASTM A424/A424M, Type I, Commercial Steel.

3. Stainless Steel Sheet: ASTM A666, Type 304.

2.03 COMPONENTS

- A. Toilet Compartments: Textured and faux Stainless steel, floor-mounted headrail-braced.
- B. General: Doors, Panels, Screens and Pilasters assembled into complete compartment system, with cutouts and drilled holes to receive hardware as indicated; processed and fabricated in a craftsmanlike manner; complying with ANSI/ICC A117.1, Americans with Disabilities Act (ADA).
 1. Panel Faces: 20 gauge, 0.0359 inch (0.91 mm).
 2. Door Faces: 20 gauge, 0.0359 inch (0.91 mm).
 3. Pilaster Faces: 20 gauge, 0.0359 inch (0.91 mm).
 4. Reinforcement: 12 gauge, 0.1046 inch (2.66 mm).
 5. Internal Reinforcement: Provide in areas of attached hardware and fittings. Mark locations of reinforcement for partition mounted washroom accessories.
- C. Door and Panel Dimensions:
 1. Compartment Depth and Width: As indicated on Drawings.
 2. Door Width: 22 inch (559 mm) minimum; at ADA accessible compartments 32 inch (813 mm) clear minimum or as required by local codes.
 3. Pilaster Width: As required to fit space; maximum 24 inches (610 mm).
 4. Pilaster Height: 70 inches (1778 mm).
 5. Pilasters Mountings:
 6. Mounting Channels: 12-gauge steel electrically welded to the pilaster face sheets.
 7. Fastening: 3/8 inch (9.5 mm) diameter studs, lock washers, nuts, and lead expansion shields.
 8. Shoes/Plinths: 4 inch (102 mm) high type 304 stainless steel plinth.
- D. Urinal Screens: Wall mounted with two panel brackets, and floor-to-ceiling vertical upright consisting of pilaster anchored to floor and ceiling.

2.04 ACCESSORIES

- A. Pilaster Shoes: Formed chromed steel with polished finish, 3 inch (175 mm) high, concealing floor fastenings.
 1. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster.
- B. Head Rails: Hollow anodized aluminum tube, 1 by 1-5/8 inch (25 by 41 mm) size, with anti-grip strips and cast socket wall brackets.
- C. Brackets: Satin stainless steel.
- D. Attachments, Screws, and Bolts: Stainless steel, tamper proof type.
 1. For attaching panels and pilasters to brackets: Through-bolts and nuts; tamper proof.
- E. Hardware: Polished chrome plated non-ferrous cast metal:
 1. Pivot hinges, gravity type, adjustable for door close positioning; two per door.
 2. Thumb turn or sliding door latch with exterior emergency access feature.
 3. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
 4. Coat hook with rubber bumper; one per compartment, mounted on door.
 5. Provide door pull for outswinging doors.
 6. FINISHING
 - a. Powder Coated Steel Compartments: Clean, degrease, and neutralize. Follow immediately with a phosphatizing treatment, prime coat and two finish coats powder coat enamel.
 - b. Color: Clear Coat Nickel Silver.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.

- B. Verify that field measurements are as indicated.
- C. Verify correct spacing of and between plumbing fixtures.
- D. Verify correct location of built-in framing, anchorage, and bracing.

3.02 INSTALLATION

- A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
- B. Maintain 3/8 to 1/2 inch (9 to 13 mm) space between wall and panels and between wall and end pilasters.
- C. Fasteners:
- D. Tamper-proof Torx Pin Head through bolts. Polished Chrome Plated Zamac.
- E. Tamper-proof Torx Pin Head through bolts. Stainless Steel No. 4 Satin finish.
- F. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.
- G. Field touch-up of scratches or damaged enamel finish will not be permitted. Replace damaged or scratched materials with new materials.

3.03 TOLERANCES

- A. Maximum Variation From True Position: 1/4 inch (6 mm).

3.04 ADJUSTING

- A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch (5 mm).

END OF SECTION 102113.13

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**SECTION 102600
WALL AND DOOR PROTECTION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Corner guards.

1.02 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design 2010.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Include plans, elevation, sections, and attachment details. Show design and spacing of supports for protective corridor handrails, required to withstand structural loads.
- C. Samples: Submit samples illustrating component design, configurations, joinery, color and finish.
 - 1. Submit two sections of corner guards, bumper rails, and protective corridor handrails, 24 inches (610 mm) long.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Corner Guards:
 - 1. Babcock-Davis; _____: www.babcockdavis.com/#sle.
 - 2. Inpro; MODEL # SAS-1824C-304: www.inprocorp.com/#sle.
 - 3. ASI AMERICAN SPECIALTIES INC..

2.02 PRODUCT TYPES

- A. Corner Guards - Flush Mounted:
 - 1. Material: Type 304 stainless steel, No. 4 finish, 18 gauge, 4-1/4" X 48" inch (_____ mm) thick.
 - 2. Width of Wings: 4-1/4" inches (108 mm).
 - 3. Corner: Square.
 - 4. Color: As selected from manufacturer's standard colors.
 - 5. Length: One piece.

2.03 FABRICATION

- A. Fabricate components with tight joints, corners and seams.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to supporting construction.
- B. Position corner guard 4 inches (102 mm) above finished floor to 52 inches high (1320.8 mm high).

END OF SECTION 102600

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**SECTION 102800
TOILET, BATH, AND LAUNDRY ACCESSORIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Commercial toilet accessories.
- B. Diaper changing stations.
- C. Utility room accessories.

1.02 RELATED REQUIREMENTS

- A. Section 06100 Rough Carpentry: Concealed supports for accessories, including in wall framing and plates.
- B. Section 102113.13 - Metal Toilet Compartments.
- C. Section 224000 - Plumbing Fixtures: Under-lavatory pipe and supply covers.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- B. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service 2022.
- C. ASTM C1036 - Standard Specification for Flat Glass 2021.
- D. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror 2018.
- E. ASTM F2285 - Standard Consumer Safety Performance Specification for Diaper Changing Tables for Commercial Use 2022.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Commercial Toilet, Shower, and Bath Accessories:
 - 1. American Specialties, Inc; _____: www.americanspecialties.com/#sle.
 - 2. Bradley Corporation; _____: www.bradleycorp.com/#sle.
 - 3. Georgia-Pacific Professional; _____: www.gppro.com/#sle.
 - 4. Substitutions: Section 016000 - Product Requirements.
- B. Under-Lavatory Pipe Supply Covers:
 - 1. Plumberex Specialty Products, Inc; _____: www.plumberex.com/#sle.
 - 2. Substitutions: Section 016000 - Product Requirements.
- C. Diaper Changing Stations:
 - 1. American Specialties, Inc; 9013-9 Stainless Steel: www.americanspecialties.com/#sle.

2.02 MATERIALS

- A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
- B. Keys: Provide 12 keys for each accessory to Owner; master key lockable accessories.
- C. Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.

2.03 FINISHES

- A. Stainless Steel: Satin finish, unless otherwise noted.

- B. Powder-Coated Steel: Clean, degrease, and neutralize. Follow immediately with a phosphatizing treatment, prime coat, and two finish coats of powder coat enamel.

2.04 COMMERCIAL TOILET ACCESSORIES

- A. Toilet Paper Dispenser: Double roll, surface mounted, for coreless type rolls.
 - 1. Products: Basis of Design
 - a. American Specialties, Inc; 20030: www.americanspecialties.com/#sle.
 - b. Substitutions: Section 016000 - Product Requirements.
- B. Paper Towel Dispenser: Electric, roll paper type.
 - 1. Cover: Stainless steel.
 - 2. Paper Discharge: Touchless automatic.
 - 3. Capacity: 8 inch diameter roll.
 - 4. Mounting: Surface mounted.
 - 5. Power: Battery operated.
 - 6. Refill Indicator:
 - 7. Products: Basis of Design
 - a. American Specialties, Inc; 68523A: www.americanspecialties.com/#sle.
 - b. Substitutions: Section 016000 - Product Requirements.
- C. Waste Receptacle: Stainless steel, freestanding style.
 - 1. Products:
 - a. American Specialties, Inc; 0839: www.americanspecialties.com/#sle.
 - b. Substitutions: Section 016000 - Product Requirements.
- D. Combination Towel Dispenser/Waste Receptacle: Semi-flush mounted, Flush mounted, stainless steel; seamless wall flanges, continuous piano hinges.
 - 1. Waste receptacle capacity: 17 gallons (64 liters).
 - 2. Products: Basis of Design
 - a. American Specialties, Inc; Model 04692A-9: www.americanspecialties.com/#sle.
- E. Automated Soap Dispenser: foam soap dispenser, wall-mounted, with stainless steel cover and window to gauge soap level, tumbler lock.
 - 1. Minimum Capacity: 32 ounces (1 liters).
 - 2. Products: Basis of Design
 - a. American Specialties, Inc; 20365: www.americanspecialties.com/#sle.
- F. Mirrors: Stainless steel framed, 1/4 inch (6 mm) thick annealed float glass; ASTM C1036.
 - 1. Annealed Float Glass: Silvering, protective and physical characteristics in compliance with ASTM C1503.
 - 2. Size: 24" x 36".
 - 3. Frame: 0.05 inch (1.3 mm) angle shapes, with mitered and welded and ground corners, and tamperproof hanging system; satin finish.
 - 4. Products: Basis of Design
 - a. American Specialties, Inc; 0600: www.americanspecialties.com/#sle.
 - b. Substitutions: Section 016000 - Product Requirements.
- G. Seat Cover Dispenser: Stainless steel, surface-mounted, reloading by concealed opening at base, tumbler lock.
 - 1. Minimum capacity: 250 seat covers.
 - 2. Products: Basis of Design
 - a. ASI American Specialties, Inc. 9477-SM.
- H. Grab Bars: Stainless steel, peened surface.
 - 1. Standard Duty Grab Bars:
 - a. Push/Pull Point Load: 250 pound-force (1112 N), minimum.
 - b. Dimensions: 1-1/4 inch (32 mm) outside diameter, minimum 0.05 inch (1.3 mm) wall thickness, exposed flange mounting, 1-1/2 inch (38 mm) clearance between wall and inside of grab bar.

- c. Finish: Satin.
- d. Length and Configuration: As indicated on drawings.
- e. Products: Basis of Design
 - 1) American Specialties, Inc; 3400-P: www.americanspecialties.com/#sle.
- I. Combination Sanitary Napkin/Tampon Dispenser: Stainless steel, surface-mounted.
 - 1. Operation: 25 cent coin required to operate dispenser. Provide locked coin box, separately keyed.
 - 2. Identify dispensers slots without using brand names.
 - 3. Minimum capacity: 15 napkins and 20 tampons.
 - 4. Products:
 - a. American Specialties, Inc; 04684: www.americanspecialties.com/#sle.
- J. Sanitary Napkin Disposal Unit: Stainless steel, surface-mounted, self-closing door, locking bottom panel with full-length stainless steel piano-type hinge, removable receptacle.
 - 1. Products: Basis of Design
 - a. American Specialties, Inc; 0852: www.americanspecialties.com/#sle.

2.05 DIAPER CHANGING STATIONS

- A. Diaper Changing Station: Wall-mounted folding diaper changing station for use in commercial toilet facilities, meeting or exceeding ASTM F2285.
 - 1. Material: Stainless steel.
 - 2. Mounting: Surface.
 - 3. Minimum Rated Load: 250 pounds (113.4 kg).

2.06 UTILITY ROOM ACCESSORIES

- A. Mop and Broom Holder: 0.05 inch (1.3 mm) thick stainless steel, Type 304, hat-shaped channel.
 - 1. Holders: Three spring-loaded rubber cam holders.
 - 2. Length: Manufacturer's standard length for number of holders.
 - 3. Basis-of-Design Product: Subject to compliance with requirements, provide ASI-American Specialties, Inc.; ASI 8215-3 - Surface Mounted or a comparable product by one of the following:
 - a. Bobrick Washroom Equipment, Inc.
 - b. Bradley Corporation.
 - c. Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc
 - d. Substitutions: 016000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.

3.02 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.03 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.

3.04 PROTECTION

- A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION 102800

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**SECTION 104400
FIRE PROTECTION SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.

1.02 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry: Wood blocking product and execution requirements.

1.03 REFERENCE STANDARDS

- A. NFPA 10 - Standard for Portable Fire Extinguishers 2022.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide extinguisher operational features.
- C. Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.
- D. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.
- E. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.05 FIELD CONDITIONS

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fire Extinguishers:
 - 1. Ansul, a Tyco Business; _____: www.ansul.com/#sle.
 - 2. Kidde, a unit of United Technologies Corp; _____: www.kidde.com/#sle.
 - 3. Nystrom, Inc; _____: www.nystrom.com/#sle.
 - 4. Potter-Roemer; _____: www.potterroemer.com/#sle.
 - 5. Pyro-Chem, a Tyco Business; _____: www.pyrochem.com/#sle.
- B. Fire Extinguisher Cabinets and Accessories:
 - 1. Kidde, a unit of United Technologies Corp; _____: www.kidde.com/#sle.
 - 2. Larsen's Manufacturing Co; _____: www.larsensmfg.com/#sle.
 - 3. Nystrom, Inc; _____: www.nystrom.com/#sle.
 - 4. Potter-Roemer; _____: www.potterroemer.com/#sle.

2.02 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
- B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
 - 1. Class: A:B:C type.
 - 2. Temperature range: Minus 40 degrees F (Minus 40 degrees C) to ___ degrees F (___ degrees C).

2.03 FIRE EXTINGUISHER CABINETS

- A. Cabinet Configuration: Recessed type.
 - 1. Size to accommodate accessories.
 - 2. Trimless type.
- B. Door: 0.036 inch (0.9 mm) metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinges.
- C. Door Glazing: Acrylic plastic, clear, 1/8 inch (3 mm) thick, flat shape and set in resilient channel glazing gasket.

- D. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
- E. Fabrication: Weld, fill, and grind components smooth.
- F. Finish of Cabinet Exterior Trim and Door: No.4 - Brushed stainless steel.
- G. Finish of Cabinet Interior: White colored enamel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Place extinguishers in cabinets.

3.03 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

END OF SECTION 104400

SECTION 123600 COUNTERTOPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall-hung counters and vanity tops.

1.02 RELATED REQUIREMENTS

- A. Section 224000 - Plumbing Fixtures: Sinks.

1.03 REFERENCE STANDARDS

- A. AWI (QCP) - Quality Certification Program Current Edition.
- B. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition 2014, with Errata (2016).
- C. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards 2021, with Errata.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for 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 and recommendations.
 - 3. Specimen warranty.
- C. Verification Samples: For each finish product specified, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.
- D. Certificate: Submit labels and certificates required by quality assurance and quality control programs.

1.05 QUALITY ASSURANCE

- A. Quality Certification:
 - 1. Comply with AWI (QCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.awiqcp.org/#sle.
 - 2. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 - 3. Provide designated labels on shop drawings as required by certification program.
 - 4. Provide designated labels on installed products as required by certification program.
 - 5. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.07 FIELD CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 COUNTERTOPS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Natural Stone Countertops: Stone slabs bonded to substrate; use as large pieces as possible with inconspicuous adhesive joints.

1. Stone: Marble without cracks, voids, or pin holes ; filling with matching epoxy resin is acceptable.
2. Color: See finish legend on AE165.
3. Quarry Name: _____; no substitutions.
4. Stone Thickness: 1/2 inch (12 mm), minimum.
5. Surface Finish: Honed, non-glare.
6. Back and End Splashes: Same material, same thickness; for field attachment.

2.02 MATERIALS

- A. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.

2.03 ACCESSORIES

- A. Fixed Top-Mounted Countertop Support Brackets:
 1. Material: Steel.
 2. Finish: Manufacturer's standard, factory-applied, textured powder coat.
 3. Color: Black.

2.04 FABRICATION

- A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
 1. Join lengths of tops using best method recommended by manufacturer.
 2. Fabricate to overhang fronts and ends of cabinets 1 inch (25 mm) except where top butts against cabinet or wall.
 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
 1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
 2. Height: 4 inches (102 mm), unless otherwise indicated.
- C. Wall-Mounted Counters: Provide skirts, aprons, brackets, and braces as indicated on drawings, finished to match.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- B. Seal joint between back/end splashes and vertical surfaces.

3.04 CLEANING

- A. Clean countertops surfaces thoroughly.

3.05 PROTECTION

- A. Protect installed products until completion of project.

- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

3.06 SCHEDULES

- A. See drawing for schedule and colors.

END OF SECTION 123600

**SECTION 211000
FIRE PROTECTION**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Connections and Fees.
- B. Firelines, Extensions as shown on Drawings.
- C. System Design Requirements per Jurisdictional Authorities.
- D. Underground Exterior Piping as shown on Drawings.
- E. Interior and Exterior above Ground Piping.
- F. Sprinkler System.
- G. Fire Department Connections.
- H. All Alarms, Switches and Required Wiring.

1.2 RELATED REQUIREMENTS

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.
- B. Section 230500 - Basic Mechanical Requirements.
- C. The 211000 Contractor shall furnish all equipment, materials, tools, labor, engineering, drawings, etc. necessary for a complete sprinkler system ready for operation in accordance with the requirements of the authority having jurisdiction. The purpose of the furnished specifications and associated drawings is to convey to the Contractor the scope of work required, all of which the Contractor is responsible to furnish, install, adjust and make operable. The Contractor shall visit the site before submitting the bid, and shall examine all existing physical conditions which may be material to the performance of his work. No extra payments will be allowed to the Contractor as a result of extra work made necessary by his failure to do so. Any case of discrepancy or lack of clarity shall be promptly identified to the Owner's Representative and Engineer for clarification.

1.3 RELATED SECTIONS

- A. Section 012300 – Alternates.
- B. Section 221410 – Plumbing Piping: Copper water piping.
- C. Section 221411 – Disinfecting Water Supply System.
- D. Section 230529 – Basic Mechanical Materials and Methods.
- E. Section 230540 – Mechanical Sound and Vibration Control.

- F. Section 230548 – Mechanical Seismic Control.

1.4 FIRE LINES

- A. The work of this section shall include extension of service mains from the existing mains in the building to the new fire riser assembly, as shown on drawings.

1.5 CONNECTIONS AND FEES

- A. System development charges and or similar charges, that in principle allow the right to obtain the services from the utility will be arranged and paid for by the Site Utilities Contractor. Division 211000 Contractor shall contact all jurisdiction authorities to verify fee requirement.
- B. Tap fees as they are known to the trade and are the charges for actual materials and labor for tapping, inspection and recording of the tap shall be arranged and paid for by the Site Utilities Contractor.
- C. In the event that the serving utility company installs their own taps, service, meters, etc., all costs imposed by this action shall be paid for by the Site Utilities Contractor
Extensions from termination points to connection with building services and systems will be the responsibility of the 211000 Contractor.
- D. Be responsible for all pads, vaults, manholes, manhole covers, valve enclosures, valves, services boxes, and required material, all in conformance with requirements of the serving utility company.
- E. Contractor shall coordinate with other trades all interface piping and types of connections to be provided for interface.
- F. Permit fees shall be provided in the base bid. The 211000 Contractor shall furnish the Owner with a copy of all official documents and written correspondence associated with permits.

1.6 DEFINITIONS

- A. The following are references with definition acronyms used in this section:
 - 1. U.L. - Underwriters Laboratory Listed for Fire Protection Systems.
 - 2. IRI - Industrial Risk Insurors (aka: F.I.A. Factory Insurance Association.)
 - 3. NFPA - National Fire Protection Association.
 - 4. Jurisdictional Agencies:
 - a. Building Department.
 - b. Fire Department or Fire Prevention Bureau or Marshal.
 - c. Insurance Agency, Carrier, and/or Underwriter as defined in Section 1.7.
 - 5. Engineer refers to the consulting Mechanical Engineer of record.
 - 6. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).
 - 7. Other definitions for fire protection systems are listed in NFPA 13.
 - 8. Working Plans as used in this Section mean those documents (including drawings and calculations) prepared pursuant to the requirements contained in NFPA 13 for obtaining approval of the authority having jurisdiction.

9. Review and Approval will be only for conformance with the design concept of the Project and for compliance with the information given in the Contract Documents and shall not extend to means, methods, techniques, sequences or procedures of construction (except where a specific means, method, technique, sequence or procedure of construction is indicated in or required by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

1.7 SYSTEM DESIGN REQUIREMENTS

- A. Sprinkler System Requirements:
 1. Provide freeze-protected portions of the building sprinkler system using dry sprinkler heads to protect vestibules and similar areas subject to freezing.
 2. Provide a wet pipe sprinkler system to protect all other areas of the building. Include protection of elevator shafts, boiler rooms, mechanical rooms, and similar areas as required by code.
 3. Sprinkler heads shall be centered in ceiling tiles in all finished areas.
 4. Provide inspector test valve and piped drain at each riser.
Existing sprinkler piping, portions of the existing piping systems will remain. This contractor to coordinate existing piping to remain and include in the overall system design and integration with new systems for a complete system.
- B. Occupancy hazard classifications shall be determined in accordance with NFPA 13 unless higher hazard classifications are indicated on the drawings or required by insurance underwriter or jurisdictional authority.
- C. Fire protection shall be designed and installed per NFPA 13 and NFPA 14 current published standards and local Jurisdictional Agency requirements. Where a conflict occurs the more stringent standard shall apply.
- D. Verify requirements with Jurisdictional authorities, i.e.: Insurance Co. or Underwriter (when specified above), Fire Department or Marshal, or Building Department. Provide system complete, functional and acceptable to Jurisdictions without penalty of any type to the insurance premium rate. Division 211000 Contractor shall coordinate his work with all other sections of these specifications and drawings. No change order will be issued for lack of coordination or lack of verification of requirements of Jurisdictional Authorities.
- E. System shall be hydraulically calculated per Jurisdictional Agency Standards.
- F. All calculations shall include flow test results. Flow tests shall be performed by this Contractor and submitted to the Fire Department. Prior flow tests on file with jurisdictional agencies may be used in lieu of new flow tests only when previous test has been made within 3 months of project start date.
- G. The system shall be designed to account for seasonal changes and for future degradation of the water supply system, using previous seasonal flow tests from the water utility to determine the expected range of pressure fluctuation at the project site.
- H. Be responsible for accurate measurements, coordination with other trades, required offsets, scheduling, timely submittals, material delivery, job manning, and conformance to construction schedules.

- I. Provide backflow protection in accordance with jurisdictional requirements. Provide backflow preventers of required types, and installed in an approved manner where shown on drawings. Verification as to acceptance by jurisdictional authority and fire insurance underwriter shall be the responsibility of this Contractor.
- J. All areas shall be classified in accordance with NFPA 13 with respect to hazard classification and shall have automatic sprinkler systems designed for the appropriate classification.
- K. The 211000 Contractor shall furnish and install all alarm and supervisory switches or devices required for the automatic sprinkler system installed so as to provide an electrically supervised system. The 211000 Contractor shall coordinate required tie-ins with the building fire alarm system with the 283111 Contractor.
- L. The number and location of fire department connections shall be coordinated with the Architect and local Fire Department. The fire department connections shall be piped directly into the building fire protection loop or standpipe system.
- M. Each sprinkler riser control valve shall be equipped with a valve supervisory switch and a waterflow switch on piping down stream of the last control valve. Drain piping for each fire protection riser shall be sized and located to accommodate full flow from the main drain under normal system pressure.
- N. This project is located within a seismic zone which is subject to earthquakes. Sprinkler systems shall be protected per NFPA 13 to prevent breakage. Existing piping noted to remain shall be included as part of the seismic bracing scope as required to bring all portions of the sprinkler system into compliance with current Code.

1.8 QUALITY ASSURANCE

- A. The firm, company, corporation, or partnership producing and providing the material and labor of this Section shall have at least 3 years experience performing scope of work described and required by these Contract Documents.
- B. Acceptable Fire Protection Contractors meeting the above requirements are as follows:
 - 1. Delta Fire Protection, Salt Lake City, UT
 - 2. Alta Fire Protection, Salt Lake City, UT
 - 3. Fire Engineering Company, Salt Lake City, UT
 - 4. Chaparral Fire Protection, Salt Lake City, UT
 - 5. Firetrol Protection Systems, Salt Lake City, UT
 - 6. Grinnell Fire Protection, Salt Lake City, UT
 - 7. Western Automatic Sprinkler, Salt Lake City, UT
 - 8. Preferred Fire Protection Company, Salt Lake City, UT
 - 9. Aurora Fire Protection, Salt Lake City, UT
 - 10. Shilo Automatic Fire Sprinkler, ID
 - 11. Frontier Fire Protection, Clearfield, UT

- C. Contractors not listed must submit for acceptance 10 calendar days prior to bid date. Proof of prior experience for Contractors not listed shall be submitted to the Engineer in writing, giving total and complete information of dates, name, address of owner, and location of all projects completed during past 3 years with specific references as to Engineers, and prime contractors involved. List names of companies, phone numbers and project manager's name.
- D. Codes and Standards:
 - 1. All work shall conform to the requirements of the currently adopted editions of the following NFPA Standards and Recommended Practices as appropriate for the type of service except as specifically noted in each Section:
 - a. "Installation of Sprinkler Systems", NFPA 13.
 - b. "Installation of Standpipe and Hose Systems", NFPA 14.
 - c. "National Electrical Code", NFPA 70.
 - d. "National Fire Alarm Code", NFPA 72.
 - e. "Inspection, Maintenance and Testing of Water- Based Suppression Systems", NFPA 25.
 - 2. All building construction work shall conform to the currently adopted edition of the International Building Code and International Fire Code.
 - 3. All work shall conform to the federal, state and local regulations governing this installation.
 - 4. Should any conflicts occur between any code or standard, the most stringent requirement(s) shall apply.
 - 5. The Fire Protection Contractor shall be subject to the interpretation of statutory requirements by the local Fire Department. Acceptance of the completed systems by the local Fire Department is required.

1.9 TECHNICAL SUBMITTALS

- A. Timely submittals are essential to on-time completion of the project. The Owner will incur no obligation to extend the contract completion date, or to reduce or waive any liquidated damages due, as a result of the Fire Protection Contractor's failure to provide the specified submittals in a timely and acceptable fashion.
- B. The information shown on each technical submittal shall be complete with respect to quantities, dimensions, specified performance and design criteria, products, materials, and similar data to enable the Owner, Engineer and Architect to review the information as required. Only complete submittals will be reviewed. Incomplete submittals will be rejected and returned to the Fire Protection Contractor without being reviewed.
- C. Each technical submittal shall include a cover letter providing a description of each variation that the submittal may have from the requirements of the Contract Documents. In addition, the Fire Protection Contractor shall provide specific notation on each Working Plan, sample, catalog cut, data sheet, installation manual, etc. submitted for review and approval, of each such variation.
- D. No construction or installation will be authorized until the required submittals are received and reviewed by the Owner, Engineer, and Architect. Any construction or installation performed without written authorization from the Owner shall be entirely at the Fire Protection Contractor's own risk.

- E. The required Technical Submittals for all systems and equipment installed in accordance with these specifications include:
 - 1. Working Plans, per NFPA 13.
 - 2. Water Supply Information, per NFPA 13.
 - 3. Hydraulic Calculations, per NFPA 13.
 - 4. Operation and Maintenance Manual.
 - 5. Test Protocols.
 - 6. Fire Protection Contractor's Material & Test Certificates for Aboveground Piping and for Underground Piping, per NFPA 13.
 - 7. Record Drawings.
- F. Provide six copies of each required Working Plan, manufacturer's data sheet, water supply information, hydraulic calculations, and test protocol submittal within 60 days of award of contract.
- G. Provide two copies of each required Operation and Maintenance Manual, Material & Test Certificates, and Record Drawing submittal a minimum of 10 working days prior to final acceptance testing.
- H. All drawings and diagrams shall be CAD generated using AutoCAD Version 2021, prepared on drawing sheets 30" x 42" in size, and shall contain no extraneous information. Marked up copies of catalog data sheets or manufacturer's "typical" diagrams are not acceptable in lieu of the required drawings or diagrams. All other information required for this submittal shall be submitted in one or more appropriately labeled and indexed 3-ring binders.
- I. All drawings and diagrams shall include the Fire Protection Contractor's title block, complete with drawing title, Fire Protection Contractor's name, address, date (including revisions), and preparer's and reviewer's initials.
- J. Upon approval of the Working Plans, including completion of any required revisions, the Fire Protection Contractor shall provide one (1) complete, reproducible set and three blueline sets for the Owner, Engineer, and Architect's use in performing field observations during construction.
- K. Working Plans for sprinkler systems shall be complete and in full accordance with NFPA 13 Chapter on Plans and Calculations.
 - 1. All drawings and calculations shall be reviewed and accepted by the jurisdictional fire department, building department fire marshal, as applicable, and the insurance carrier or insurance reviewing authority prior to submitting to the Engineer. Indication of review and acceptance by all agencies, as appropriate, shall be certified by name of reviewer, agency, and date affixed to the plans or reproducibles submitted to the Engineer. None will be accepted or reviewed until compliance with these terms has been established.

- L. Operation and Maintenance Manuals shall be prepared specifically for this project and bound in an indexed 3-ring binder, containing:
 - 1. A detailed description of routine maintenance and testing as required and recommended and as would be provided under a maintenance contract, including a testing and maintenance schedule and detailed testing and maintenance instructions for each type of device installed. This description shall include:
 - a. A listing of the individual system components that require periodic testing and maintenance.
 - b. Step-by-step instructions detailing the requisite testing and maintenance procedures and the intervals at which those procedures should be performed, for each type of device installed. These instructions shall include copies of NFPA 25 - Inspection, Testing and Maintenance of Water-Based Fire Protection Systems and NFPA 72 - National Fire Alarm Code.
 - 2. A schedule, which correlates the step-by-step testing and maintenance procedures with the listing of individual components. This schedule shall be completed for the duration of the warranty period or for one complete testing/maintenance cycle whichever is longer.
 - 3. A service directory, including installing company's name and telephone numbers for whoever should be called to obtain both normal warranty service and 24-hour emergency service.
 - 4. Drawings and diagrams, as required.
 - 5. System Calculations.
 - 6. Test reports for system, flow rates, and residual pressures.
 - 7. Certified pump curves (all pumps).
 - 8. Wiring diagrams for all system devices.
- M. Upon completion of the installation, submit Record Drawings and Contractor's Material & Test Certificates for Aboveground Piping and for Underground Piping, per NFPA 13.
- N. Record Drawings shall include all variations from the approved Working Plans, for whatever reason, including those occasioned by modifications, change orders, optional materials and/or required coordination between trades. Variations shall be indicated in sufficient detail to accurately reflect the as-built conditions. Upon completion of the work, before final acceptance, the Fire Protection Contractor shall deliver to the Owner, two (2) additional full size sets of blue lines and one set of AutoCAD drawing data files.

1.10 PROJECT CONDITIONS

- A. Contractor shall not install any piping until he has assured himself that the piping can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

1.11 WARRANTIES

- A. Provide original copies of all warranties and extended warranties for specific equipment where specified and in accordance with Section 230500.

PART 2 PRODUCTS

2.1 PRODUCT LISTINGS AND APPROVALS

- A. All system components for which UL listings categories exist shall be listed by Underwriters Laboratories (UL) or Factory Mutual Research (FM).
 - 1. All components shall be listed in the current edition of the UL Fire Protection Equipment Directory. Components shall be delivered to the project site with factory applied UL stickers.
 - 2. Components for which UL listing approvals are “pending” are not acceptable.
- B. All system components shall be used in accordance with the manufacturer’s recommendations and their listing.
- C. All system components are subject to the approval of the engineer with regard to their fitness for the intended application.

2.2 UNDERGROUND EXTERIOR PIPING

- A. Pipe, Fittings and Joints, Exterior and Buried:
 - 1. General: The use of cast-iron, asbestos cement, steel, or other piping materials and systems is prohibited, unless specifically accepted by the Engineer.
 - 2. Pipe Fittings and Joints:
 - a. Ductile iron pipe with mechanical joint fittings. Joints to be provided with set screw retainer glands.

Make:	U.S. Pipe Company
Size:	2" thru 48"
Laying Condition:	Type 1
Thickness Class:	50 or 51 as required by U.S. Pipe.
Standards:	ANSI A21.SD/A21.51 AWWA C-150/151, U.L., F.M., NSF.
Pressure Rating:	250 psi
Fittings:	Ductile iron conforming to ANSI A21.10/A21.16 and AWWA C-110/111.
Retaining Glands:	Set screw type ductile.
Hydrant Connections:	Tee DI rotatable x MJ Hydrant Connector. DI rotatable 13" long x MJ

3. Polyvinylchloride pipe with mechanical joint, ductile fittings, and joint restraints:

Make:	Manville "Blue Brute".
Size:	4" thru 12"
Laying Condition:	Type 1 as defined by U.S. Pipe Co.
Class:	200 (DR 14) as determined by dia. of pipe O.D. divided by the wall thickness (SDR method) conforming to ASTM D-1599 burst test (985 psi minimum) and minimum 100 ft-lbs of impact per ASTM D-2444. Meet all requirements of AWWA C-900, U.L., F.M., and N.S.F.
Pressure Rating:	200 psi minimum operating @ 73 deg. F
Fittings:	Ductile iron conforming to ANSI A21.10/A21.11 and AWWA C-110/111 Mechanical Joint pattern only.
Retaining Glands:	Do not use set screw retaining glands on this pipe. Use felt padded pipe clamps, coated rods, and concrete thrust blocks for all turns, offsets, and fittings.

Note: Straight lengths of piping, not offset or deflected, may be J-M "Ring Tite" locked joints in lieu of mechanical joint ductile iron connectors or fittings.

4. Fiberglass reinforced PVC pipe with mechanical joint ductile iron fittings, for use where pressures exceed 200 psi up to 350 psi:

Make:	Manville "Blue Brute".
Size:	4" thru 12"
Laying Condition:	Type 1 as defined by U.S. Pipe Co.
Class:	350 (4"=DR 32, 6" & 8"=DR 36, 10" & 12"=DR 41)
Pressure Rating:	350 psi minimum operating @ 73 deg. F
Fittings:	Ductile iron conforming to ANSI A21.10/A21.11 and AWWA C-110/111 Mechanical Joint pattern.
Retaining Glands:	Do not use set screw retaining glands on this pipe. Use felt padded pipe clamps and coated rods and concrete thrust blocks for all turns, offsets, and fittings.

Note: Straight lengths of piping not offset or deflected may be J-M "Lock-ring" joints in lieu of mechanical joint fittings or connectors.

5. Rotatable Fittings:

- a. Provide for all service risers, fire hydrants and valves, U.S. Pipe Company U-591 and U-592 MJ x PE or rotatable MJ gland tees and connecting pieces to provide plumb and true hydrant, valve and service riser settings.

- B. Backflow Preventer: Furnish and install backflow preventer where shown on drawings.
 - 1. Double check detector assembly, U.L. Classified, FM Approved, with OSY inlet/outlet shut-off valves and bypass meter assembly. Watts 757DCDA series, or equal as approved via addendum. Refer to drawings for additional details.
- C. Thrust Blocks - Tie Rods:
 - 1. Provide 3000 lb type II concrete thrust blocks with soil contact area based on not more than 2000 psf horizontal soil bearing quality, and enveloping 1/2 of pipe, fitting, or valve. Provide saddle reinforcing as required.
 - 2. Submit calculations for each thrust block and dead man provided.
 - 3. Provide 1/2" minimum machine thread rods and clamps (felt padded clamps for plastic pipe) on all service entries from last joint underground to riser elbow or wall entry and to first joint in the building. All rods, clamps, and bolts double coated with "ZRC" brand cold galvanizing coating after installation and draw up. Provide 1 coat of coal tar coating over galvanizing. NOTE: Clamps and rods to not preclude the requirements for thrust blocks or deadmen.
- D. Cathodic Protection:
 - 1. Provide 8 mil thick minimum polyethylene pipe wrap, overlap at joints and seal joint with 2" wide minimum polyethylene tape triple wrapped and extending at least 6" both ways beyond joint seam or provide machine wrapped scotchwrap #51 PVC tape with 50% overlap wrap on pipe primed with scotchwrap primer. Double wrap all fittings to 6" beyond fitting onto pipe. Provide primer on fittings, bolts, and nuts prior to wrapping.

2.3 SOLVENTS FOR PLASTIC PIPING

- A. Solvents for plastic piping joints shall be certified to meet SCAQMD Rule 1168/316A. This includes but is not limited to PVC, CPVC, and ABS piping, all grades and sizes.

2.4 INTERIOR AND EXTERIOR ABOVE-GROUND PIPING

- A. Pipe and Joints:
 - 1. Black steel and galvanized steel threaded or grooved schedule 40 conforming to ASTM A-135 or A-53. All pipe shall conform to NFPA #13, Chapter 3 and Jurisdictional Authorities and Insurance Agency. All dry pipe system and drain piping and fittings shall be schedule 40 galvanized with threaded or cut grooved joints.
- B. Fittings:
 - 1. Threaded cast iron, pressure class in accordance with developed system pressures, conforming to ASME B16.4. Threaded malleable iron, pressure class in accordance with developed system pressures, conforming to ASME B16.3. Threaded ductile iron, pressure class in accordance with developed system pressures, conforming to ASTM A-536 and ASME B 16.3.

2. Weld type fittings: Buttweld conforming to ASME B16.9. Flanges conforming to ASME B16.25. Socket weld conforming to ASME B16.11. All welds by certified welder in accordance with Section 230529.
 3. Grooved fittings shall conform to ASTM-A47 (malleable), ASTM 536 (ductile), or ASTM-106 GRB (forged steel), ASTM A-53 type E, F, or S GRB (nipples), ASME B-16.5 or B16.1 cast iron and carbon steel flanges.
- C. Flexible Connectors:
1. Flexible connector to be stainless steel (304) corrugated tube surrounded with stainless steel (304) wire braid. Provide threaded fittings on each end of the flexible connector.
 2. Connector shall have the frictional equivalent of a maximum of 23 ft. of 1" steel pipe (assumes 4' long tube with four 90° bends).
 3. Connectors shall be UL listed, F.M. approved.
 4. Provide with support bracing and clamps.
- D. Valves:
1. All valves are to be indicating type.
 2. All valves U.L. listed, F.M. approved.
 3. Refer to Section 230529 for valve specifications.
- E. Hangers:
1. All hangers, attachments and components U.L. listed, F.M. approved.
 2. All piping hangers shall conform to Jurisdictional Authorities requirements.
 3. Powder driven studs shall not be included in normal installation. Permission to use this type anchoring system must be accepted by the Structural Engineer prior to submitting pricing or bids to any contractor or agent relative to this project.

2.5 SPRINKLER SYSTEM

- A. Acceptable Manufacturers: The following manufacturers are acceptable, providing the product to be considered is equivalent in every respect to the nomenclature, style, material, finish, and color provided by the specified make and model.
1. Sprinkler Heads, Alarm, Dry and Deluge Valves, Accelerators, Detector Check Valves, Alarm Horn/Strobe, Air Maintenance Devices, Sprinkler Emergency Cabinets, and Specialties: Reliable, Viking, Notifier, Victaulic, Croker, Potter, Elkhart, Tyco.

B. Sprinkler Heads:

Heads shall be U.L. Listed and of the type required to properly protect the intended space. Heads shall be of ordinary-temperature classification except as required by ceiling temperature, location, or service as allowed or required by code. Provide quick-response heads in all light hazard occupancies.

LOCATION	ORIENTATION	HEAD FINISH	COVER OR ESCUTCHEON
Office	Concealed	Brass	White
Conference Rooms	Concealed	Brass	White
Elevator Lobbies	Concealed	Brass	White
Entry Lobby	Concealed	Brass	White
Storage	Concealed	Brass	White
Corridors	Concealed	Brass	White
Open Areas (No Ceilings)	Upright/Pendant	Brass	-
Equipment Rooms	Upright/Pendant	Brass	Chrome
Dock	Upright/Pendant	Brass	-

C. Escutcheons shall be part of the U.L. Listed sprinkler assembly.

D. Sprinkler Head Cabinets:

1. Steel with red enamel finish for 6, 12, or 24 heads complete with appropriate heads, wrench and mounting.

E. Sprinkler Head Guard:

1. Steel wire cage, chrome finish.

F. Water Flow and Pressure Switches:

1. Paddle Type Flow Switch U.L. Listed, for pipe sizes 1" thru 8", for vertical or horizontal mounting, retard adjustment from 0 to 70 seconds instantly recycling, 10 amp, 120v AC, dual contacts. Notifier Model WFD, or approved equal.
2. Pressure Switch for dry, deluge, alarm, and pre-action valves, U.L. Listed, 10 amp, 120v AC, dual contacts. Potter Model PS40A, or approved equal.

G. Supervisory Switches:

1. Post indicator valve, and gear operator type, U.L. Listed, weatherproof metal housing, threaded conduit entrance, 10 amp, 120v AC, dual contacts. Notifier Model PIBV2, or approved equal.
2. Gate, OS&Y, and other valves, U.L. Listed, weatherproof metal housing, threaded conduit entrance, 10 amp, 120v AC, dual contacts. Notifier Model OSY2, or approved equal.

H. Alarms:

1. Exterior Audible and Visual Alarm, U.L. Listed for outdoor use, weatherproof faceplate, horn and strobe. Notifier Model GMS, or approved equal.

2.6 FIRE DEPARTMENT CONNECTION – (FDC)

- A. Cast brass, single clapper fire department inlet connection. Provide hose inlets of sizes, styles, and patterns required, brass caps and chains, and brass identification baseplate with lettering denoting system served. Number of inlets shall be determined by sprinkler hydraulic calculations. Inlet hose threads shall match requirements of local Fire Department. FDC shall be configurable for reverse flow to accommodate forward flow testing of the fire line backflow preventer via bypass valve at riser.
- B. Style: Freestanding.
- C. Finish: Polished Brass.

PART 3 EXECUTION

3.1 PREPARATION

- A. Field Measurements: Verify all dimensions before proceeding with the work. Obtain field measurements for work required to be accurately fitted to other construction. Be responsible for the accuracy of such measurements and precise fitting and assembly of finished work. Prefabrication of systems is done at this Contractor's own risk.
- B. Coordination: Coordinate all work and placement of components with other trades, thorough coordination of design and field installation is expected. Remedial field work may be required to eliminate conflicts and provide an acceptable finished product.

3.2 EXCAVATION, BACKFILL, CUTS AND RESTORATION

- A. Provide all excavations and backfill in accordance with Section 230529 - Basic Mechanical Materials and Methods.
- B. Cuts - Restoration:
1. All concrete, asphalt, or other hard permanent surface shall be saw cut. Turf areas shall be cut clean with straight edge.
 2. Restore all planted, paved, and surfaced areas to original color, texture and condition, replanting where necessary and left in the same or better condition as was found existing.

3.3 INSTALLATION

- A. General: Provide a complete operable system designed and installed in accordance with applicable local, state, federal and jurisdictional codes, enforcement agencies and insurance rating or underwriting agencies.
- B. All systems shall be drainable with proper drainage devices, and drain terminations either to exterior of building or to proper receptacles within building.

- C. All systems shall be supported and braced for conformance to proper and applicable standards.
- D. Care shall be taken with chrome plated or other polished finish components so that marring does not occur to the finish, and installation provides for a uniform pattern and true installation.
- E. Where piping passes thru masonry units or concrete walls or floors or other building construction, sleeves may be used. Where exposed piping passes thru finished work, chrome plated, or other finish acceptable to Architect, split wall plates or escutcheons shall be installed to fit snugly around piping. Where rated walls are penetrated, approved safing shall be provided at each hole to assure effectiveness of construction as a fire stop.
- F. All openings for piping should be anticipated and coordinated with General Contractor. Indicate such openings on the shop drawings. Any additional cutting of openings must be coordinated with the General Contractor.
- G. Contractor shall complete the automatic fire sprinkler, standpipe ready for operation, in all respects, as soon as possible. When system is complete and ready for continuous operation, activate the system for its intended use. After system has been activated for continuous use, water charges, if any will be paid for by the Owner.
- H. Use no face bushings.
- I. Furnish and install all wiring for all flow switches, tamper switches, exterior and interior alarm items furnished in this Section. This work may be subcontracted to the Division 26 Contractor if desired by the Section 211000 Contractor but the Section 211000 Contractor shall include the wiring costs in his bid.
- J. Provide seismic restraints for new and existing sprinkler piping in accordance with Jurisdictional Agencies.
- K. The sprinkler piping shall be concealed from view in all common and public areas with a finished ceiling. Exposed piping shall be cleaned and left ready for painting by others.
- L. Provide seismic separation assembly in accordance with NFPA 13 where pipes cross building seismic separation joints or expansion joints.

3.4 PERFORMANCE

- A. General: Systems shall be engineered and designed for proper densities, ease of maintenance and accessibility. Final main drain flow tests shall be made to prove system design and installation.

3.5 CLEANING

- A. General: Flush all systems free of all debris and certify system clean and ready for use.

3.6 TESTING AND CERTIFICATE OF COMPLETION

- A. The entire system shall be hydrostatically tested at not less than 200 psig for not less than 2 hours with 0 psig pressure drop. Tests shall be witnessed by the Architect's or General Contractor's representative - mandatory.

- B. Obtain certificate of compliance and completion for jurisdictional agencies, as applicable and present to Owner - mandatory.

END OF SECTION 211000

**SECTION 221410
PLUMBING PIPING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Water Piping.
- B. Soil, Waste and Vent Piping.
- C. Storm Water Piping.
- D. Testing.

1.2 RELATED REQUIREMENTS

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.
- B. Section 230500 - Basic Mechanical Requirements.

1.3 RELATED SECTIONS

- A. Section 230529 - Basic Mechanical Materials and Methods.
- B. Section 230540 - Mechanical Sound and Vibration Control.
- C. Section 230548 - Mechanical Seismic Control.
- D. Section 230700 - Mechanical Insulation.
- E. Section 221411 - Disinfecting Water Supply System.
- F. Section 221430 - Plumbing Specialties.
- G. Section 224440 – Plumbing Fixtures.
- H. Section 224450 – Plumbing Equipment.

1.4 SUBMITTALS

- A. Submit Product Data for the following items under provisions of the General Conditions of the Contract:
 - 1. Water Piping, Fittings, and Joints.

PART 2 PRODUCTS

2.1 WATER PIPE, TUBE, FITTINGS AND JOINTS

A. Exterior Buried:

1. Copper Tube, Fittings, and Joint Material:
 - a. Copper tube ASTM B88 Type K shall be soldered, to wrought or cast fittings using 95-5 class SnSb (Tin-antimony) solder.
 - b. Wrought copper and bronze solder joint fittings shall conform to ANSI B16.22.
 - c. Cast bronze solder joint fittings shall conform to ANSI B16.18.
2. Cast Iron Pipe Fittings and Joints:
 - a. Gray cast iron pipe, centrifugally cast, 18/40 physicals, cement lined, mechanical joint, thickness class 23 minimum. 300 psi minimum working pressure "laying condition A" as designated by USA Standard A21.1 and 8 foot bury.
 - b. Mechanical joints and fittings shall be furnished with set screw retaining glands and shall conform to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11.
 - c. Mechanical joint fittings shall be Ductile Iron, 350 psi working pressure up to 24" size.
3. Ductile Iron Pipe Fittings and Joints:
 - a. Class 150, ductile iron pipe centrifugally cast, thickness class 2, cement lined, mechanical joint, 350 psi minimum working pressure "laying condition A" as designated by USA Standard A21.51 and 8 foot bury.
 - b. Mechanical joints and fittings shall be furnished with set screw retaining glands and shall conform to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11.

B. Interior Buried:

1. Provide type K annealed (soft) copper water tube conforming to ASTM B-88 with 95% tin 5% antimony solder joints using wrought fittings. No joints below grade. Provide continuous tube for all buried tubing using tube bends in lieu of fittings. Exterior tube may be coupled where requirements are in excess of standard mill lengths by using wrought pressure couplings with stops and silver solder brazed Joints. Lengths coupled in this manner, where necessary and acceptable to the Engineer, will meet the intent of the no fitting requirement of this Specification. Interior buried tube shall meet the same criteria and requirements.

C. Interior Tube Supported by Hangers and Clamps:

1. Provide ASTM B88 Type L hard drawn copper tube for all water distribution piping inside building/structure, with wrought copper fittings and couplers up to 6", cast brass or bronze fittings and couplers for sizes 6" and larger. Joints shall be 95-5 Class SnSb solder or Victaulic CTS roll-grooved couplers and fittings for 3" and larger tube.

2.2 SOIL DRAIN WASTE, VENT AND STORM PIPE FITTINGS AND JOINTS

A. General:

1. Cast iron pipe centrifugally cast service weight (SV) soil pipe with cast iron drainage fittings conforming to ASTM A 74. Joint materials and systems may be hub and spigot with neoprene gaskets and lubricant conforming to ASA-021 and ASTM C-564 SV pattern. Gaskets shall be equal to U.S. Pipe Company Veri-tite conforming to ASTM-C564 and pipe and fittings be certified in writing to the Engineer that the following criteria has been met, thru testing by a recognized independent testing laboratory. Cast iron hubless pipe and fittings conforming to ASTM A 888, CISPI 301. Hubless couplings shall conform to ASTM C 1277 for standard and ASTM C 1540 for heavy duty or CISPI 310. Pipe and fittings shall be marked with the collective trademark of the cast iron soil pipe institute or receive prior approval of the engineer.

Criteria: Sizes 2" thru 6" shall withstand 15 psig hydrostatic pressure for 10 minutes with unrestrained joints, and no leakage, and using restrained joints must be able to withstand 25 psig air pressure and 40 psig hydrostatic pressure with no leakage. Offset joints shall withstand 1056 pounds of horizontal force without joint separation or detectable leakage.

B. Buried Pipe:

1. Provide SV hub and spigot cast iron pipe and fittings to 5'-0" beyond building excavation line, continue past this point with SV cast iron or XS vitrified clay to termination points with hub and spigot joints.

C. Interior Pipe Supported By Hangers and Clamps:

1. Provide hubless cast iron pipe using hubless cast iron soil pipe couplings certified to withstand a minimum of 50 psi internal pressure. Where stack pressures may theoretically exceed 50 psi, use clamp all or heavy-duty couplings with restrained joints horizontal and vertical up to 80 psig. For pressures above 80 psi, use Schedule 40 ASTM A-120 galvanized steel pipe with threaded cast iron drainage fittings. Roll grooved schedule 40 pipe with Victaulic Style 77M galvanized couplers may be used on horizontal and vertical stacks and mains. Use Teflon tape or compound for all threaded joint make-up.
2. Sump pump discharge from the pump to the point the waste stream flows continuously via gravity shall be Schedule 40 galvanized steel pipe with NPT threaded joints and fittings.
3. Copper Waste, Vent and Soil Pipe and Fittings shall be prohibited on this project.

PART 3 EXECUTION

3.1 WATER TUBE, FITTINGS AND JOINTS

- A. General:
 - 1. All copper tube and fittings shall be reamed and buffed prior to soldering or brazing.
 - 2. The use of lead solder of any class, for joint make-up or back-up for finishing is prohibited.
 - 3. Refer and conform to the Copper Development Association instructions for proper preparation and actual installation practice for all soldered and brazed joints.
 - 4. Support water tube in accordance with Section 230529.
 - 5. Pull tee (T-drill) fittings are forbidden.
- B. Domestic Hot Water Circulating Systems:
 - 1. Provide a calibrated balancing valve in each branch line and where additional valves are shown on the drawings.

3.2 CLEANING

- A. Remove temporary coverings and protection of adjacent work areas.
- B. Repair or replace damaged installed products.
- C. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance.
- D. Remove construction debris from project site and legally dispose of debris.

3.3 PROTECTION

- A. Protect installed work from damage due to subsequent construction activity on the site.

3.4 SOIL, DRAIN, WASTE, VENT AND STORM PIPE FITTINGS AND JOINTS

- A. General:
 - 1. Provide bedding, restraints and hangers as appropriate and in accordance with manufacturers recommendations based upon type of pipe, fittings, joints, and bury depth using final finished grading as the basis.
 - 2. Piping shall be run true, plumb, and straight, with all restraints and hangers adjusted to carry their proportional load and locked to prevent pipe "wag" misalignment, movement or shear.
 - 3. Provide anchors for piping risers on every floor using riser clamps, wall brackets, knee brackets, and foot blocks for all vertical piping over 20 feet straight height.
 - 4. Furnish and install all soil, waste and vent piping for the complete sanitary system in accordance with jurisdictional code requirements.

5. All soil and waste piping shall be run at the following minimum slope unless otherwise indicated on drawings.

Slope of Horizontal Drainage Pipe	
Size (In.)	Min. Slope (In./Ft.)
2-1/2 or less	1/4
3 to 6	1/8
8 or larger	1/16

6. Bushings in soil waste or vent piping shall be prohibited. Tapped spigots or tees shall be used when changing from cast iron pipe to steel waste or vent piping, and for appropriate cleanout plugs.
7. Vertical Piping: All vertical soil and vent stacks shall be supported with riser clamps at each floor slab. When soil stacks over two stories in height terminate at the bottom on slab fill or native soil, provide stack base elbows set on 24" x 24" x 8" thick minimum poured reinforced concrete pads set directly on undisturbed native soil or fill compacted to same density as undisturbed earth.
8. Horizontal Piping (suspended):
- a. Supports - Horizontal piping shall be supported at sufficiently close intervals to keep it in alignment and prevent sagging.
 - b. Cast iron soil pipe - Where joints occur, suspended cast iron soil pipe shall be supported at not more than five (5) foot intervals; except that pipe exceeding five (5) feet in length, may be supported at not more than ten (10) foot intervals. Supports shall be adequate to maintain alignment and prevent sagging and shall be placed within eighteen (18) inches of the hub or joint. Hubless or compression gasket joints must be supported at least at every other joint except that when the developed length between supports exceeds four (4) feet, they shall be provided at each joint. Supports shall also be provided at each horizontal branch connection. Supports shall be placed on or immediately adjacent to the coupling. Suspended lines shall be suitably braced to prevent horizontal movement.
 - c. Threaded pipe - Threaded pipe (IPS), shall be supported in accordance with Section 230529.
 - d. Rigid support sway bracing shall be provided at changes in direction greater than 45 degrees for pipe sizes 4 inches and larger.
 - e. For pipe sizes greater than 4 inches, axial restraints shall be provided for drain pipes at all changes in direction and at all changes in diameter greater than two pipe sizes.
9. The waste connections between fixtures and their respective collection and venting systems shall consist of galvanized steel nipples and cast iron drainage fittings.
10. All interior waste, soil, and vent piping up to 1-1/2" shall consist of galvanized steel with cast iron drainage fittings, all piping 1-1/2" and over shall consist of S.V. cast iron soil pipe and fittings.
11. All pipe and fittings shall have affixed thereon the CISPI grade mark of identification.
12. All vents shall be installed through the roof of at least the minimum size as required by jurisdictional code and shall be cast iron.

13. All vents protruding through the roof shall be not less than 2" size and extended to not less than 12 inches above the finished roof. Vents through built-up roofing shall be flashed with 24" x 24" x 4 lb. sheet lead. The flashing shall extend to top of vent and the edges turned down into a cast iron vent pipe. Single ply rubberized roofing systems shall be flashed around vent with top edge of roofing clamped to vent pipe and sealed with compatible sealant.
14. All vents shall be located in accordance with jurisdictional code and in no case less than two (2) feet from roof edge or parapet, or wall line of an "on the roof structure". Vent terminations shall not occur within twenty-five (25) feet of any outside air intake.
15. Provide all expansion joints, braces, earthquake restraints as required by the contract documents (Section 230548) and jurisdictional authority.

3.5 PROHIBITED PIPE ROUTING

- A. Plumbing piping, regardless of contents (water, sewer, vent, etc.) shall not be routed through or above the following locations:
 1. Electrical panel rooms
 2. Electrical switch gear rooms
 3. Electrical transformer rooms
 4. Elevator shafts
 5. Elevator equipment rooms
 6. Data Centers
 7. File Server Rooms / MDF / IDF
- B. Should there be a conflict with the plans and the above paragraph, notify the Engineer immediately for corrective action prior to starting work.

3.6 TESTING

- A. Schedule of Testing:

Service	Allowable Test Methods				Minimum Test Pressure (psig)	Minimum Test Period (minutes)	Allowable Pressure Variance (psig)
	H ₂ O	CA	N ₂	V			
1. Potable Water Pipe Valves & Fittings	X	X			125 100	60 60	-0- +1/2
2. Sanitary, Storm and Vent System:							
*Stack Height:							
0-23 FT.	X				10	30	-0-
24-34 FT.	X				15	30	-0-
35-46 FT.	X				20	20	-0-
47-57 FT.	X				25	20	-0-
58-69 FT.	X				30	10	-0-
70-80 FT.	X				35	10	-0-
81-92 FT.	X				40	10	-0-
93-103 FT.	X				45	10	-0-
Over 104 FT.	X				50	10	-0-

- B. Testing connections for hydrostatic tests shall be made at the base of the system, CA, N2 and vacuum testing can be made from connections anywhere in the system tested.
- C. In the event that tests fail, use a standard soap and brush inspection using "Trouble Bubble" Liquid high density soap as manufactured by Jersey Meter Co., Patterson N.J. Formula ST-1. After source of failure is discovered, correct and retest system. Repeat procedure until system sustains required testing successfully.
- D. Testing contractor shall give at least 16 working hours notice to the General Contractor/Construction Manager so that arrangements for witnessing tests can be made. The General Contractor/Construction Manager shall witness and SIGN the required test form.
- E. All joints, valves, fittings and piping accessory items shall be exposed to view during tests whether pipe is above or below ground. "Closed in" or "Buried" piping shall be re-exposed during testing.
- F. Proper restraining of piping and test plugs shall be accomplished prior to test.

END OF SECTION 221410

**SECTION 221411
DISINFECTING WATER SUPPLY SYSTEM**

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Disinfection of Domestic Water Supply System.

1.2 RELATED WORK

- A. Requirements: Provide Disinfecting Water Supply System in accordance with the Contract Documents.
- B. Section 230500 - Basic Mechanical Requirements.
- C. Section 221410 - Plumbing Piping.

1.3 DEFINITIONS

- A. Disinfectant residual means the quantity of disinfectant in treated water.
- B. pH factor means the measure of alkalinity and acidity in water.
- C. ppm means parts per million.

1.4 CONTRACTOR'S QUALIFICATIONS

- A. Water Treatment Contractor: At least three years experience performing work specified herein.
- B. Bacteriological Laboratory: Certified by Serving Water Board or District and be in compliance with the State and U.S. Safe Drinking Water Act.

1.5 REGULATORY AGENCY REQUIREMENTS

- A. Comply with requirements of Local and State Regulations.

1.6 SUBMITTALS

- A. Submit for review and acceptance the following items under provisions of the General Conditions of the Contract:
 - 1. Water treatment contractor's evidence of experience.
 - 2. Bacteriological laboratory's evidence of certification.

- B. Submit printed data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:
1. Disinfection Report:
 - a. Include the following:
 - Date issued.
 - Project name and location.
 - Treatment Contractor's name, address, and phone number.
 - Type and form of disinfectant used.
 - Time and date of disinfectant injection start.
 - Time and date of disinfectant injection completion.
 - Test locations.
 - Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
 - Time and date of flushing start.
 - Time and date of flushing completion.
 - Disinfectant residual after flushing in ppm for each outlet tested.
 2. Bacteriological Report:
 - a. Include the following:
 - Date issued.
 - Project name and location.
 - Laboratory's name, certification number, address and phone number.
 - Time and date of water sample collection.
 - Name of person collecting samples.
 - Test locations.
 - Time and date of laboratory test start.
 - Coliform bacteria test results for each Outlet tested. Certification that water conforms or fails to conform to bacterial standards of State and Federal Safe Drinking Water Act.
 - Bacteriologist's signature.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Protect against damage and discoloration.
- B. Maintain caution labels on hazardous materials.
- C. Maintain storage room dry and with temperatures as uniform as possible between 60 deg.F and 80 deg.F.
- D. Do not store Caustic Soda directly on floor colder than 55 deg.F.

1.8 PROTECTING WORK OF OTHER TRADES

- A. Provide necessary signs, barricades, and notices to prevent any person from accidentally consuming water or disturbing system being treated.
- B. Protect against damage and discoloration caused by work of this Section.

PART 2 PRODUCTS

2.1 DISINFECTANT

- A. Free chlorine; liquid, powder, tablet, or gas.

2.2 ALKALI

- A. Caustic Soda or Soda Ash.

2.3 ACID

- A. Hydrochloric type.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

- A. Prior to starting work, verify that Domestic Water System is completed, flushed and clean.
- B. Prior to starting work, notify Construction Manager/General Contractor of any defects requiring correction.
- C. Do not start work until conditions are satisfactory.

3.2 PREPARATION OF WATER FOR TREATMENT

- A. Verify pH factor of water to be treated.
- B. If pH factor is less than 7.4, introduce sufficient alkali during disinfectant injection to produce 7.4 to 7.6 pH level.
- C. If pH factor is greater than 7.6, introduce sufficient acid during disinfectant injection to lower pH to 7.4 to 7.6 level.

3.3 SYSTEM TREATMENT

- A. Inject disinfectant throughout system to obtain 50 to 80 ppm residual.
- B. Starting at outlet closest to water sources, bleed water from each outlet until water produces odor of disinfectant. Repeat process at each outlet throughout system.
- C. Test for disinfectant residual at each of the following locations:
 - 1. Ends of piping runs.
 - 2. Remote outlets. (Ends of each multiple fixture branch line)
 - 3. Tanks and domestic water heaters.
 - 4. At least 15% of outlets on each floor as directed by Architect/Engineer.
- D. Maintain disinfectant in system for 24 hours.
- E. If resultant disinfectant residual test is less than 25 ppm, repeat System Treatment.

3.4 FLUSHING

- A. Flush disinfectant from entire system; permit no more than residual rate of supplied incoming water.

3.5 BACTERIOLOGICAL TEST

- A. Instruct Bacteriological Laboratory to take water samples no sooner than 24 hours after flushing system.
- B. Take water samples at each of the following locations:
 - 1. Where water enters system.
 - 2. Ends of piping runs.
 - 3. Remote outlets.
 - 4. Tanks.
 - 5. At least 10% of outlets on each floor other than those used for testing disinfectant residual, where directed by Architect/Engineer, but in no case less than 2 outlets per floor.
- C. Analyze Water Samples in accordance with Standard Methods for the examination of Water & Waste Water, published by American Water Works Assoc., 6666 W. Quincy Ave., Denver, CO 80235.
- D. If Bacteriological Test proves water quality to be unacceptable, repeat System Treatment.

3.6 PRODUCT CLEANING & REPAIRING

- A. Including work of other trades, clean, repair and touch-up, or replace when directed, products which have been soiled, discolored, or damaged by work of this Section.
- B. Remove debris from Project Site upon work completion or sooner, if directed.

END OF SECTION 221411

**SECTION 221430
PLUMBING SPECIALTIES**

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Drains and drainage products.
- B. Cleanouts.
- C. Sump pans and drain flashings.
- D. Hose bibbs.
- E. Pressure gauges, thermometers, and test plugs.
- F. Water hammer arrestors.
- G. Backflow preventers.
- H. Pressure reducing valves.
- I. Pressure and temperature relief valves.
- J. Trap guards.

1.2 RELATED WORK

- A. Requirements: Provide Plumbing Specialties in accordance with the Contract Documents.
- B. Section 230500 - Basic Mechanical Requirements.
- C. Section 230529 - Basic Mechanical Materials and Methods.

1.3 SUBMITTALS

- A. Submit Product Data for the following items under provisions of the General Conditions of the Contract:
 - 1. Floor Drains (FD)
 - 2. Floor Sinks (FS)
 - 3. Cleanouts (FCO, WCO, COTG)
 - 4. Hose Bibbs (HB)
 - 5. Pressure Gauges (PG)
 - 6. Thermometers (T)
 - 7. Water Hammer Arrestors
 - 8. Backflow Preventers (BFP, RBPB)
 - 9. Pressure Reducing Valves (PRV)
 - 10. Trap Guards

- B. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:
 - 1. Backflow Preventer (BFP, RPBP)
 - 2. Pressure Reducing Valves (PRV)
- C. Submittal data for existing and/or salvaged equipment being reinstalled is not required. Refer to plans for locations and/or details of existing and/or salvaged equipment being reinstalled for reuse.

1.4 WARRANTIES

- A. Provide original copies of all warranties for specific equipment where specified and in accordance with Section 230500.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Where acceptable manufacturers are listed, these manufacturers must submit products that are in fact equivalent in all respects of materials, design, function, and appearance to the manufacturer listed as the base manufacturer in the specification body or drawing schedules. Deviations of any type will not be acceptable.
- B. Where other acceptable manufacturers are not listed, only the base manufacturer will be accepted.
- C. All items of like nomenclature shall be supplied by one manufacturer only.

2.2 FLOOR DRAINS (FD-1)

- A. Acceptable manufacturers: Wade 1100 series, JR Smith 2005 series, Josam 30000 series, Zurn Z-415 series, Watts FD-100 series, MIFAB F-1100 series.
- B. Schedule: See Drawings
 - Note 1: Provide flashing clamp device for drains in areas with waterproof membrane and all drains above slab-on-grade.
 - Note 2: Finished areas, showers, toilets, etc.

2.3 FLOOR DRAINS, HEAVY DUTY (FD-2)

- A. Acceptable manufacturers: Wade 1240 series, JR Smith 2330 series, Josam 31200 series, Zurn Z-512 series, Watts FD-340 series, MIFAB F-1340C series.

B. Schedule: See Drawings

Note 1: Provide flashing clamp device for drains in areas with waterproof membrane and all drains above slab-on-grade.

Note 2: Mechanical equipment rooms, shops, etc.

2.4 FLOOR SINKS (FS-1)

A. Acceptable manufacturers: JR Smith 3201 series, Josam 49420 series, Zurn 1926 series, Watts FS-850 series.

B. Schedule: See Drawings

Note 1: Provide flashing clamp device for drains in areas with waterproof membrane and all drains above slab-on-grade.

Note 2: Indirect waste and floor drainage for mechanical equipment rooms.

2.5 FLOOR CLEANOUTS (FCO-1)

A. Acceptable manufacturers: Wade series 6000, JR Smith series 4020/4100/4200, Josam series 56000, Zurn series Z-1400, Watts CO-200-R/200-RX/200-US series, MIFAB series C1100-R/C1100-XR/C1100-UR.

B. Cast iron adjustable body, ABS plug.

1. Provide flange and flashing clamp for Cleanouts in areas with waterproof membrane and all cleanouts above slab-on-grade.

2. Provide nickel bronze top to match floor finish as indicated in the Architectural finish schedule. Provide heavy duty nickel bronze top for cleanouts in storage rooms, kitchens, and similar areas. Provide heavy duty cast iron or ductile iron top for cleanouts in equipment rooms, traffic areas, parking areas, and similar unfinished areas.

2.6 WALL CLEANOUTS (WCO-1)

A. Acceptable manufacturers: Wade series 8560 with 8480R, JR Smith series 4530, Josam series 58790, Zurn series 1441, Watts CO-460-RD series, MIFAB series C-1460.

B. Cast iron clean out tee, ABS plug, stainless steel cover with screw.

2.7 GRADE CLEANOUTS (COTG-1)

A. Acceptable manufacturers: Wade series 8300 MF with 6000 spigot outlet, JR Smith series 4250, Josam series 58850, Zurn series Z-1474 with Z-1449, Watts CO-300 series, MIFAB series C-1300.

B. Heavy duty cast iron clean out housing, heavy duty cast iron or ductile iron cover, cast iron ferrule, ABS plug, vandal proof security screws.

1. Provide piping system identification cast into cover; "SAN" for sanitary waste cleanouts, "STORM" for storm drainage cleanouts.

2.8 SAFE PANS AND DRAIN FLASHINGS

- A. Provide one of following systems:
1. #24 B&S gauge (0.021") minimum sheet copper with 15 lb. asphaltic felt sub pan (underliner).
 2. 0.040" non-plasticized chlorinated polyethylene sheet with 30 lb. felt underliner.
 3. 3 ply 15 mil polyvinylchloride sheet with 30 lb. felt underliner.

2.9 WATER HEATER AND STORAGE TANK SAFE PANS

- A. Provide fabricated 18-gauge stainless steel safe pans with hemmed edges and fully welded watertight corners that extend no less than six inches beyond all sides of water heaters and hot water storage tanks. Pans shall be no less than three inches deep and shall be fitted with a 1-1/2" diameter welded steel drain fitting. Entire safe pan bottom shall be supported by concrete housekeeping pads with no gaps or overhangs.

2.10 HOSE BIBBS (HB-1)

- A. Acceptable manufacturers: Woodford 26, Prier 165, JR Smith 5672-BFP, Zurn 1341-BFP.
- B. Schedule: See Drawings
1. Furnish with ASSE 1052 approved backflow preventer.

2.11 STATIONARY PRESSURE GAUGES (PG)

- A. Acceptable manufacturers: Terrice 600C Series, Weksler Instrument Regal Series, Weiss Instruments, Weksler Glass.
- B. Schedule:

Type	4-1/2" Dial
Bourbon Tube/Socket	Stainless Steel Tube 316 Stainless Steel Socket
Accuracy	ANSI B40.1 Grade 1A 1% F.S. over middle half of range
Case	Cast Aluminum
Window	Clear Glass
Snubber	Yes
Coil Syphon	For Steam Service
Gauge Cock	Yes
Set Hand	No
Silicone Filled	No
Weatherproof	No

C. Range: Select gauges for the following standard ranges unless otherwise indicated on drawings, or as required for special systems.

- 1. Domestic Water 0 to +160 psi
- 2. Pump Gauges -30 in Hg to +100 psi

2.12 STATIONARY THERMOMETERS (T)

A. Acceptable manufacturers: Trerice Industrial Series, Ametek Industrial Series, Weiss Instruments, Miljoco, Weksler Instrument, Weksler Glass.

B. Schedule:

Type	Adjustable angle
Case	9" cast aluminum
Window	Clear acrylic
Tube	Lens front, magnifying
Stem	Aluminum, insertable
Separable Socket	Brass
Fill Type	Spirit: Blue colored, organic

C. Range: Select thermometers, for the following standard ranges unless otherwise indicated on Drawings, or as required for special systems.

- 1. Domestic cold water 0 to 100 °F
- 2. Domestic hot water 30 to 240 °F

2.13 TEMPERATURE AND PRESSURE TEST PLUGS

A. Manufacturer: Trerice, Fairfax, Flow Design, Peterson Equipment, Weksler.

B. Plugs suitable for vacuum up to 600 psig and temperatures of -20 deg.F to 300 deg.F with cap and extension for insulated pipe where required.

C. Provide one pressure gauge(s), gauge adapter, and two thermometers in shock-proof case.

D. Schedule:

PLAN CODE:	MAKE:	MODEL:	PRESSURE & TEMPERATURE TEST KIT
T&PTP	Trerice	D3741	Trerice D3751 (0-200 psig)

2.14 WATER HAMMER ARRESTORS

A. Manufacturer: J.R. Smith series 5000, Josam series 75000, Wade series 4480, Watts SS series, Zurn Z-1700.

- B. Bellows-style with stainless steel housing, bellows, and pipe connection.
- C. Maximum rated working pressure not less than 125 psig, maximum rated static pressure not less than 250 psig. Rated operating temperature range: 33°F to 300°F.
- D. Water hammer arrestors shall be tested and certified by an independent lab in accordance with PDI WH-201 and ASSE 1010.
- E. Schedule:

"P.D.I." SIZE	FIXTURE UNITS
A	1-11
B	12-32
C	33-60
D	61-113
E	114-154
F	155-330

P.D.I. Size as defined in the Plumbing and Drainage Institute Standard PDI WH-201.

2.15 REDUCED PRESSURE BACKFLOW PREVENTER – 1/2” TO 2” (RPBP)

- A. Acceptable manufacturers: Watts Series LF009 and LF919, Febco Series 825Y, Zurn Series 975XL2, Beeco Series FRP.
- B. Bronze body, independent spring-loaded check valves, diaphragm type differential pressure relief valve, shut-off ball valves, strainer, test cocks, and air gap drain fitting. Suitable for water temperature range of 33-140 °F.
- C. Approved under ASSE 1013 and AWWA C511.
- D. Backflow preventer test kit: Provide complete test kit including pressure gauge, test valves, high pressure hoses, adaptor fittings, mounting strap, and instructions, in a corrosion resistant carrying case. Provide one test kit capable of testing all building backflow preventers.

2.16 REDUCED PRESSURE BACKFLOW PREVENTER – 2-1/2” AND LARGER (RPBP)

- A. Acceptable manufacturers: Watts Series 994, Zurn Series 375AST, Beeco Series Barracuda 40.
- B. Stainless steel body, independent spring-loaded check valves, stainless steel relief valve, shut-off NRS gate valves, strainer, test cocks, and air gap drain fitting. Suitable for water temperature range of 33-140 °F.
- C. Backflow preventer shall be equipped with a water/flood sensor. Sensor shall be wired to generate an alarm to the BMS upon detection of excessive water discharge from the relief valve.
- D. Approved under ASSE 1013 and AWWA C511.

2.17 PRESSURE REDUCING VALVE – 1/2” TO 2” (PRV)

- A. Acceptable manufacturers: Watts Series LF223, Zurn Series 500XL, Caleffi Series 535H.
- B. 300 psi bronze body, replaceable seat, strainer, adjustable outlet pressure, thermal expansion by-pass. Suitable for water temperature up to 160 °F.
- C. Approved under ASSE 1003 and IAPMO.

2.18 TEMPERATURE AND PRESSURE RELIEF VALVES (T&P)

- A. Acceptable Manufacturers: Kunkle, Watts, Conbraco, McDonnell and Miller.
- B. Schedule:

TYPES	SIZE	MAKE	MODEL	SERVICE	MAX PRESS	ASME MAX TEMP	ASME RATING BTUH MAXIMUM
T & P	3/4"	Kunkle	137	Water Pressure Vessel	125 psig	250 F	2,230,000
Press	3/4"	Kunkle	84-45	Air	125 psig	300 F	NA
Vac	3/4"	Kunkle	80-45	Vacuum	15" Hg	300 F	NA
T & P	3/4"	Watts	40XL8	Water Heater	125 psig	210 F	777,600

2.19 TRAP GUARDS

- A. Elastomeric Trap Seals: Normally closed trap seal device intended to prevent evaporation of water in the trap and to protect against sewer gases from migrating into occupied spaces, while allowing liquid to pass through into the drain body and building drainage system. Device installs inside drain tail piece that threads into the drain body, and shall be fully replaceable after the drain body has been cast into the concrete floor slab without the need to remove drain body from the concrete slab. Trap seal to be tested in accordance with ASSE Standard 1072. All products to be ASSE certified in accordance with ASSE 1072, or evaluated by the ICC Evaluation Service and listed under ICC-ES-PMG as an alternative to trap primers.
 - A. Elastomeric Trap Seals shall be manufactured in USA and shall include a manufacturer's 10 year warranty. Devices made of silicone are not allowed.
 - B. Elastomeric Trap Seals shall seal air-tight against a backpressure not less than 10" w.c., and shall allow water to flow through the drain at rates in compliance with the performance requirements of ASSE 1072.
 - C. Manufacturer: ProVent Systems 'Trap Guard', Jay R. Smith Quad Close Trap Seal, or approved equal.
- B. Provide a deep seal trap with water column not less than 4" tall as measured from top of u-bend to bottom of outlet pipe, at all drains and floor sinks where a trap primer or trap seal device is required.

PART 3 EXECUTION

3.1 DRAINS

- A. Coordinate drain placement with Contractor for Division 3 - Concrete.
- B. Drain, strainer, and grate finishes shall be as specified, protect all finished surfaces during construction to prevent damage.
- C. Install drains with "P" pattern traps and vents as required.
- D. Fixture drain bodies shall be plugged during construction to prevent foreign objects, dirt, concrete, etc. from entering the drain and drainage piping.
- E. Drains shall be set flush and level with finished surfaces, with grate pattern parallel or perpendicular to adjacent walls or floor patterns.
- F. Flash drains on roofs, upper floors, and floor over crawl spaces with 24"x24" minimum flashing pans. Shower pans shall be turned up in walls to a minimum of 6" above the shower receptor threshold.
- G. Clean and polish drain bowls, rims, strainers, and grates prior to final inspection.

3.2 CLEANOUTS

- A. Provide cleanouts in waste, soil, and storm piping at each change in direction greater than 45°, as required by Jurisdictional Code.
- B. Provide cleanouts at 50-foot intervals for interior sanitary and storm piping, and at each base of waste, soil or storm pipe stack or drop. Provide cleanouts at 100-foot intervals for exterior sanitary and storm piping or as required by jurisdictional code.
- C. Provide appropriate access tops for imposed construction.
- D. Coordinate interior floor cleanout locations with contractor for Division 3 - Concrete.
- E. Cleanouts shall be provided with ABS or Delrin plugs. Lead sealed, brass, or cast iron plugs will not be acceptable unless specifically required by jurisdictional code authority.
- F. Provide 24"x24" minimum flashing pans and clamp devices for cleanouts located on upper floors or floors over crawl spaces.
- G. Where cleanout arms extend horizontally and/or vertically more than 15 feet from the sewer main which they are serving, provide 2" minimum vent off the end of the arm and connect to the building vent system.
- H. Clean and polish cleanout access covers prior to final inspection.
- I. Cleanout access covers shall be flush and level with finished building surfaces.
- J. Install cleanout plugs on exposed or accessible piping. Plugs shall be line size up to 3" and over 8", 4" plugs for sizes 4" thru 8".
- K. Provide wall cleanouts where piping is concealed in walls or non-accessible chases. Use tapped cleanout tee or tapped extension to within 4" of wall face. Do not use no-hub type blind plugs for wall cleanouts.
- L. Provide 12"x12"x8" thick 3000 lb. concrete pads for all grade cleanouts. Concrete shall be in accordance with Division 3 - Concrete. Tops of pads shall be 1" above finished grade and cleanout access flush and level and centered in pad surface.

3.3 SAFE PANS AND DRAIN FLASHINGS

- A. Provide safe pans for shower bases, shower rooms, wet rooms, and kitchen areas. Pans shall extend wall to wall and turn up at least 6" above finish floor level or receptor rims into wall construction. Pans shall be laid over non-puncturing base such as heavy asphaltic felt, fine sand that bears no silica, or other acceptable material.
- B. Drains on upper floors or over crawl spaces shall be flashed with flashing extending a minimum of 12" beyond the drain top dimensions.
- C. Seams shall be folded and shaped as required:
 - 1. Solder lead seams.
 - 2. Solder sheet copper seams with 50/50 (50% tin, 50% lead) or 45/55 (45% tin, 55% lead) commercial grade solder.
 - 3. Solvent weld PVC and un-plasticized chlorinated polyethylene seams.

3.4 WATER HEATER AND STORAGE TANK SAFE PANS

- A. Provide safe pans for water heaters and storage tanks with storage capacity greater than 40 gallons.
- B. Provide structural supports, air gapped pan drains, drain extensions, and pan drain connections as required.

3.5 HOSE BIBBS (HB)

- A. Provide hose bibbs in equipment rooms and toilet rooms equipped with floor drainage systems and where shown on drawings, maximum spacing shall accommodate 50 feet of hose to any point within the drainage area measured around obstructions and equipment, in lieu of straight line measurement. Hose bibbs in toilet rooms shall be mounted under standard lavatory, do not install near ADA lavatory where it could impede access.
- B. Anchor hose bibb within wall for rigid flush flange mounting.
- C. Install bibb true and plumb with wall flange flush to surface, caulk annular space between wall and flange.
- D. Mounting height shall be 18" above floor in toilet rooms and immediately under furthest lavatory from entry, 60" above floor in equipment rooms or as shown on drawings.
- E. Hose bibbs shall not be operated with hand tools, use only tee handle, furnish one tee handle per bibb. Units found marred due to hand tool operation or other causes will be replaced at Contractors expense.
- F. Clean and polish hose bibbs prior to final inspection.

3.6 STATIONARY PRESSURE GAUGES (PG)

- A. Provide gauges for steam, water, air and vacuum systems, complete with gauge cocks and snubbers, where required by Drawings.
- B. Install in semi or upright position, tilted so as to be readable from floor level.
- C. Clean gauge, and glass, and calibrate by test prior to final inspection.

3.7 STATIONARY THERMOMETERS (T)

- A. Install thermometers where indicated on Drawings in upright position with case tilted to be readable from floor level.
- B. Clean case and glass prior to final inspection.

3.8 TEMPERATURE AND PRESSURE PLUGS

- A. Provide plugs where periodic temperature and/or pressure indication is required and as shown on drawings. Provide 1/4" MPT tapping, cap and seal for plug and extension for insulated pipe as applicable.

3.9 WATER HAMMER ARRESTORS

- A. Provide water hammer arrestors in accordance with Plumbing Drainage Institute (PDI) Standard WH-201 and as shown on drawings.
- B. Provide 8"x8" minimum access panels centered on each shock arrestor that is otherwise inaccessible.
- C. Shock arrestors shall be mounted as close to the line or quick closing valve as possible. Remote mounting or excessive (over 6") nipple mounting will not be acceptable.
- D. Provide ball valve at each shock arrestor to allow units to be easily removed/replaced.

3.10 REDUCED PRESSURE BACKFLOW PREVENTERS (RPBP)

- A. Provide reduced pressure type backflow preventers on connections between the domestic water system and make-up supplies to any non potable system, i.e.: Heating, Boilers, Cooling Towers, Chiller, Evaporative Coolers, and the like.
- B. Anchor backflow preventer in place.
- C. Clean and test assembly in place in accordance with State Health Code.
- D. Provide funnels and attach to unit per manufacturers instructions, in true, level and plumb position.
- E. Provide IPS to solder adaptor to funnel outlet and run type M copper tubing in an unobtrusive manner routed to an approved drain receptor.
- F. Hang and anchor drain tubing so as to be rigid and stable.
- G. Permanently affix drain outlet at drain receptor so as to be rigid and unmovable.

3.11 PRESSURE REDUCING VALVE (PRV)

- A. Provide unistrut or similar frame for mounting all components of the pressure reducing valve station.
- B. Arrangement shall be as shown on Drawings including by-pass.
- C. Provide drain valves both sides of station on headers on low points.
- D. Provide unions, strainer, valves, petcocks, gauges, straps and other accessories as detailed on Drawings.
- E. Set each pressure reducing valve using full system pressure and flow individually to outlet pressures specified.

- F. All gauges shall be installed to be readable from floor level. Provide petcocks on each gauge connection.

3.12 TEMPERATURE AND PRESSURE RELIEF VALVES (T&P)

- A. Provide temperature and pressure relief valves, with full size drains extended and air gapped to floor drains or approved receptor. Provide relief valves on all water heaters, pressure vessels and closed piping systems.

3.13 TRAP GUARDS

- A. Elastomeric Trap Seals: Use manufacturer provided o-ring or gaskets to seat device in drain tailpiece in accordance with manufacturer's instructions.

END OF SECTION 221430

**SECTION 224440
PLUMBING FIXTURES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Plumbing Fixtures and Trim.
- B. Plumbing Fixture Accessories.

1.2 RELATED REQUIREMENTS

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this section and Contractor shall review and adhere to all requirements of these documents.
- B. Section 230500 - Basic Mechanical Requirements.

1.3 RELATED SECTIONS

- A. Section 221410 – Plumbing Piping.
- B. Section 221430 – Plumbing Specialties.
- C. Section 224450 – Plumbing Equipment.
- D. Section 230529 – Basic Mechanical Materials and Methods.

1.4 REFERENCES

- A. Comply with the applicable provisions and recommendations of the following:
 - 1. ASME A112.19.1 - Enameled Cast Iron Plumbing Fixtures.
 - 2. ASME A112.19.2 - Ceramic Plumbing Fixtures.
 - 3. ASME A112.19.3 - Stainless Steel Plumbing Fixtures.
 - 4. ASME A112.19.4M – Porcelain Enameled Formed Steel Plumbing Fixtures.
 - 5. ASME A112.19.5 – Trim for Water-Closet Bowls, Tanks, and Urinals.
 - 6. ASME A112.6.1M – Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
 - 7. ASSE 1037 – Performance Requirements for Pressurized Flushing Devices for Plumbing Fixtures.
 - 8. IAPMO/ANSI Z124.5 – Plastic Toilet Seats.
 - 9. NSF 61/NSF 372 – Drinking Water System Components – Health Effects.
 - 10. UL 399 – Standard for Safety Drinking Water Coolers.
 - 11. ANSI Z358.1 – Emergency Eyewash & Shower Standard

1.5 SYSTEM DESCRIPTION

- A. Provide all plumbing fixtures, materials, labor, accurate rough-in setting, leveling and adjustments of all fixtures, trim, and specialties.

1.6 QUALITY ASSURANCE

- A. Qualification:
 - 1. Provide fixtures trim and specialties in accordance with style, type, quality, and function as established by the named manufacturer and model specified for each item.
 - 2. Provide all installations in accordance with jurisdictional code and health authorities standards, restrictions, and recommendations.
 - 3. Provide all fixtures and trim using a single manufacturer where possible, deviation will be allowed only where specifications indicate otherwise.

1.7 SUBMITTALS

- A. Submit Product Data for the following items under provisions of the General Conditions of the Contract:
 - 1. Fixtures.
 - 2. Flush Valves and Faucets.
 - 3. Finishes, material and colors.
 - 4. Mixing Valves.
- B. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:
 - 1. Flush Valves and Faucets.
 - 2. Mixing Valves.

1.8 WARRANTIES

- A. Provide original copies of all warranties and extended warranties for specific equipment where specified and in accordance with Section 230500.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Cast iron and vitreous china: American Standard, Crane, Eljer, Kohler, Mansfield, Sloan, Toto, Zurn.
- B. Terrazzo: Acorn, Bradley, Fiat, Florestone, Stern Williams.
- C. Urinals: American Standard, Kohler, Mansfield, Sloan, Toto, Zurn.
- D. Drinking Fountains: Acorn, Cordley, Elkay, Filtrine, Halsey Taylor, Haws, Murdock, Oasis, Sunroc.
- E. Point-of-Use Thermostatic Mixing Valves (ASSE 1070): Amstrong International, Bradley, Delta, Kohler, Lawler, Leonard, Powers, Symmons, Watts.

- F. Flush Valves: American Standard, Aquaflush, Delany, Moen, Sloan, Speakman, Toto, Zurn.
- G. Traps, Stops, Supplies, Airgaps, Drains: American Standard, Brasscraft, Bridgeport, Dearborn, Delta, Eastman, Eljer, Frost, Kohler, McGuire, Sayco, Zurn.
- H. Fixture Carriers: Josam, J.R. Smith, Mifab, Wade, Watts, Zurn.
- I. Faucets: American Standard, Bradley, Chicago, Delta, Eljer, Elkay, Kohler, Moen, Speakman, Symmons, T&S Brass, Valley, Watts, Zurn.

2.2 PLUMBING FIXTURE SCHEDULES

- A. Refer to Schedules on Drawings.

2.3 POINT-OF-USE THERMOSTATIC MIXING VALVES

- A. Adjustable high temperature limit stop (factory set for 110°F), thermostatic type, inlet checkstops.
- B. Provide ASSE 1070 approved mixing valves to serve public handwashing fixtures. In restrooms with multiple handwashing fixtures, a single valve may be used to serve multiple fixtures.

2.4 FIXTURE SUPPLIES & STOPS

- A. Standards: Comply with the following.
 - 1. NSF Standards: Comply with NSF61 and NSF372 for supply-fitting materials that will be in contact with potable water.
 - 2. ASME A112.18.1 – Plumbing Supply Fittings.
- B. Supply Piping: Chrome plated brass or chrome plated copper tube matching water supply piping size. Include chrome plated brass or stainless steel wall flange.
- C. Supply Stops: Chrome plated brass, quarter turn, ball type, with inlet connection matching supply piping.
- D. Operation: Wheel handle or loose key, as indicated in schedules.
- E. Risers: Size as indicated on drawings and schedules. Chrome plated, rigid copper pipe and brass straight or offset tailpieces; chrome plated soft copper flexible tube; or ASME A112.18.6 braided or corrugated stainless steel flexible hose.

2.5 FLUSH VALVE FILTER

- A. South Fork Manufacturing "Dirt Grabber" Flush Valve Filter #SFDG1.

PART 3 EXECUTION

3.1 INSPECTION

- A. Examination: Examine the contract documents and provide all necessary attachments, accessories, support equipment and materials as necessary to fit allocated spaces.

3.2 PREPARATION

- A. Field Measurements: Verify all dimensions and installation requirements so that work can be accurately fitted to other construction and in accordance with the intent of the contract documents. Be responsible for accuracy of measurements and adequate space requirements for the precise fitting and assembly of finished work.
- B. Refer to Architectural drawings for installation location and height for all plumbing fixtures.

3.3 INSTALLATION/APPLICATION/PERFORMANCE/ERECTION

- A. Water Closets:
 - 1. Wall Mounted
 - a. Anchor closet carriers to the floor structure in accordance with manufacturer's installation instructions.
 - b. Anchor wall mounted water closets with brass mounting studs on a concealed metal carrier. Transmitting fixture weight loads to the fixture pipe connection or wall framing is not acceptable.
 - c. Set water closets and trim level and plumb.
 - d. Space water closets in accordance with contract documents and jurisdictional codes.
 - e. Install flush valves serving water closets located within ADA stalls with the flush handle to the "open side" of the toilet stall (opposite of the grab bar side).
 - 2. Floor Mounted
 - a. Anchor floor mounted water closet flanges to the floor with lag screws, or bolts and expanders as appropriate for floor construction.
 - b. Anchor water closet bowls to the floor flanges.
 - c. Provide fixture bolt caps to match fixture color for all exposed fixture bolts and nuts.
 - d. Set water closets and trim level and plumb. Insert copper shims under base of bowl if required to level unit.
 - e. Space water closets in accordance with contract documents and jurisdictional codes.
 - f. Install flush valves serving water closets located within ADA stalls with the flush handle to the "open side" of the toilet stall (opposite of the grab bar side).

3. Water Closet Supplies
 - a. Rough-in supplies with "L" copper tube nipple through wall/floor cut to exact length and finished with escutcheon, matching fixture trim finish.
- B. Lavatories:
 1. Wall and Counter Mounted
 - a. Anchor wall mounted lavatory carriers to the floor structure in accordance with manufacturers installation instructions.
 - b. Furnish Carriers with a metal mounting plate and bearing plate or concealed arm carriers.
 - c. Support wall mounted lavatories with concealed metal carriers. Transmitting fixture weight loads to the fixture pipe connection is not acceptable.
 - d. Wood or metal mounting plates anchored to the wall framing or studs is not acceptable.
 - e. Carriers are to become part of the structure and the lavatories are not allowed to exert any weight or stress on the interior wall.
 - f. Set lavatories and trim level and plumb.
 - g. Space lavatories in accordance with contract documents and jurisdictional codes.
- C. Urinals:
 1. Wall Mounted
 - a. Anchor wall mounted urinal carriers to the floor structure in accordance with manufacturer's installation instructions.
 - b. Support wall mounted urinals with concealed metal carriers. Transmitting fixture weight loads to the fixture pipe connection is not acceptable.
 - c. Wood or metal mounting plates anchored to the wall framing or studs are not acceptable.
 - d. Carriers are to become part of the structure and the urinals are not allowed to exert any weight or stress on the interior wall.
 - e. Set urinals and trim set level and plumb.
 - f. Space urinals in accordance with contract documents and jurisdictional codes.
 - g. Install urinals in accordance with manufacturers installation instructions.
- D. Service Sink:
 1. Install service sink in accordance with manufacturers installation instructions.
 2. Set Terrazzo service sinks set on a minimum of 1/4" of silica free sand bedding shimmed with copper shims.
 3. Anchor wall mounted service sink trap standards to the floor structure in accordance with manufacturers installation instructions.
 4. Install mop hangers over service sinks, on wall adjacent and perpendicular to faucet mounting, so mops drain into sink.
 5. Install hose brackets and attach hoses to service sink faucets.
 6. Set Service sinks and trim level and plumb.

- E. Drinking Fountain:
 - 1. Wall Mounted
 - a. Anchor drinking fountain to structure in accordance with manufacturer's installation instructions.

- F. Sinks:
 - 1. Provide separate trap and waste to wall for each sink compartment shall be separately trapped and wasted to wall, continuous waste is not acceptable.
 - 2. Provide undercounter dishwasher waste with air gap fitting through sink backledge and waste to a dishwasher directional tee upstream of sink trap. Do not connect dishwasher to disposer tap inlet.
 - 3. Furnish separate loose key angle or straight stops on dishwasher supplies.

- G. Fixture Supplies and Stops:
 - 1. Provide fixture supplies and stops on every individual fixture or appliance.
 - 2. Provide compression by compression type stops with flexible straight copper tube risers, loose key or wheel handles stops. Provide one key per fixture for all loose key (L.K.) stops.
 - 3. All components, stops, risers, inlet pipe and escutcheon are chrome plated brass, polished stainless steel, or special finish as specified for fixture trim.
 - 4. Anchor supplies and stops behind walls, eliminating push or pull movement.

- H. Escutcheon Plates:
 - 1. Provide cast brass chrome plated single piece escutcheons for all penetrations of piping thru walls, floors, or ceilings in finished and unfinished areas.

- I. Faucets and Flushometers:
 - 1. Anchor faucets and flushometers behind walls, eliminating any push or pull movement.

- J. Caulking:
 - 1. Caulk all wall and floor mounted fixtures with a non-hardening white or fixture color match for colored fixtures adhesive elastomeric sealant compound providing a watertight seal at the joint with the walls or floor.

3.4 ELECTRICAL COORDINATION

- A. Coordinate plumbing fixture electrical requirements with Division 26 Scope of Work.

3.5 FIXTURE CONNECTIONS

- A. Provide supply and waste connections for fixtures in accordance with the information on the plumbing fixture schedules or larger to accommodate horizontal fixture branches, as required by jurisdictional codes, or drawings.

3.6 ADJUSTMENT AND CLEANING

- A. Adjustment: Adjust all flush valves, faucets, metering devices, shower heads, gas, air and vacuum cocks, and bubblers for proper flow and action after flushing operations are accomplished.
- B. Cleaning: Clean all fixtures, trim, accessories and attachments including strainers, traps, aerators, and valves.

END OF SECTION 224440

**SECTION 224450
PLUMBING EQUIPMENT**

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Water Heaters and Accessories
- B. Storage Tanks
- C. Digital Mixing Valve Manifold with Pump
- D. Sumps and Pumps
- E. Sewage Ejectors

1.2 RELATED WORK

- A. Requirements: Provide Plumbing Equipment in accordance with the Contract Documents.
- B. Section 230500 - Basic Mechanical Requirements.
- C. Section 230529 - Basic Mechanical Materials and Methods.
- D. Section 230540 - Mechanical Sound and Vibration Control.
- E. Section 230548 - Mechanical Seismic Control.
- F. Section 221410 - Plumbing Piping.
- G. Section 221430 - Plumbing Specialties.
- H. Section 231123- Natural Gas Systems.
- I. Section 235100 - Breechings, Chimneys, Stacks and Flues.

1.3 SUBMITTALS

- A. Submit product specification data for the following items under provision of The General Conditions of the Contract:
 - 1. Water Heaters, Accessories and Controls.
 - 2. Storage Tanks.
 - 3. Digital mixing valve manifold with pump.
 - 4. Sumps and Pumps.
 - 5. Sewage Ejectors.

- B. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:
 - 1. Water Heaters and Accessories.
 - 2. Storage Tanks.
 - 3. Digital mixing valve manifold with pump.
 - 4. Sumps and Pumps.
 - 5. Sewage Ejectors.

1.4 WARRANTIES

- A. Provide original warranties for specific equipment of term specified and in accordance with Section 230500.

PART 2 PRODUCTS

2.1 PRODUCT ACCEPTANCE

- A. Acceptable Manufacturers are listed for each product, and manufacturers shall submit products that are in fact equivalent in all respects of material, design, function, size, and appearance to the manufacturer specified. Deviations of any type will not be acceptable.
- B. Where acceptable manufacturers are not listed, only the manufacturer specified will be accepted.
- C. All equipment of like use and nomenclature shall be supplied by one manufacturer only.

2.2 CONDENSING GAS-FIRED STORAGE TYPE WATER HEATERS AND ACCESSORIES

- A. Acceptable manufacturers and models: A.O. Smith Cyclone Series, Bock Optitherm, Rheem Triton series, American Water Heaters Polaris, PVI Platinum, Lochinvar Shield, Bradford White.
- B. Provide glass lined ASME tank rated for 150 psi, 300 psi test, AGA Certified, and in conformance with ASHRAE 90.1 Energy Conservation Standards.
- C. Provide ASME certified pressure and temperature relief valve, modulating power burner, 100% pilot and main burner safety shut off, electronic ignition.
- D. Provide unit suitable for sealed combustion direct venting, with corrosion resistant enameled steel jacket, blanket or foam insulation, dielectric unions for water connections, anode rod or power non-sacrificial anodes, ball-type drain valve, combustion chamber access and manhole. Unit shall be approved for 0" clearances to combustibles.
- E. Provide minimum three year full non prorated warranty.
- F. Burners shall be orificed for natural gas fuel at jobsite altitude.
- G. Unit shall have a peak thermal efficiency of not less than 94% and have an ultra-low NOx burner.
- H. Include microprocessor controls allowing setting of discharge water temperature and with digital display showing operating mode, all user settings, and all failure/alarm modes.

- I. Provide unit with UL Listed vent material as defined in Specification Section 235100 or polypropylene vent material as approved by manufacturer. Material for combustion air (intake) piping shall match vent material. Vent piping shall be designed for condensing flue gasses and have a drain for removing liquid condensate from vent system. Do not use vent material that is not UL listed. Provide a condensate neutralization trap that operates with gravity and requires no domestic water supply. Unit shall include connection point for ducted combustion air.
- J. Unit to be capable of operating with minimum 100 equivalent feet of vent length.

2.3 DOMESTIC HOT WATER STORAGE TANKS

- A. Acceptable Manufacturers: A.O. Smith, Bock, Rheem, PVI, Bradford White, Lochinvar.
- B. Refer to drawing equipment schedules for tank capacity, dimensions, and weight.
- C. Provide an ASME and NSF certified and labeled domestic hot water storage tank for 150 psig working pressure. Tank manufacturer shall provide tappings of sizes, type, and locations required for a complete installation.
- D. Tank shall be glass lined or constructed of stainless steel for corrosion resistance. Anode rods shall be provided as necessitated by tank material.
- E. Storage tank shall be factory-insulated to meet the requirements of AHSRAE 90.1-2016. Factory insulation shall be covered with a powder coated steel jacket.
- F. Provide ASME temperature and pressure relief valve, tank drain valve, anti-siphon valve, and dielectric unions for all piping connections at tank.

2.4 DIGITAL MIXING VALVE MANIFOLD WITH CIRCULATING PUMP

- A. Acceptable Manufacturers: Leonard Megatron Digital, Bradley Navigator Digital, PVI Digitemp, Powers IntelliStation.
- B. Description: Factory-fabricated, exposed-mounting, electronically controlled, water-mixing-valve assembly, with domestic hot water circulating pump and pump contactor, of capacity, voltage, and phase as indicated on schedules.
- C. Unit shall be furnished with digital mixing valve and controls with LED display; inlet ball and check valves; outlet ball valve; outlet test connection with ball valve; integral RTD temperature sensors for mixing valve outlet, inlet hot water, inlet cold water, and return water temperature; integral pressure sensors for inlet hot water, inlet cold water and mixing valve outlet; 0.25 GPM minimum flow capacity; subassembly with return piping, aquastat, circulator pump, ball valves, and check valves; and integral GFCI outlets.
- D. Digital Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff ball valve on outlet.
- E. Component Pressure Ratings: 125 psig minimum, unless otherwise indicated.
- F. Pump manufacturers as selected by mixing valve manifold system manufacturer.
- G. System mounted on galvanized steel strut, vibration isolated, with brackets for mounting on wall. Factory pre-assembled and tested.

- H. Circulator electrical connections factory wired to H-O-A switch with status lights and contactor. Division 230900 controls system will signal pump to start and stop based on programmed time schedule.

2.5 SUMP PUMPS

- A. Acceptable Manufacturers:

1. Enpo-Cornell
2. Hydromatic
3. Kenco
4. Weil Pump Company
5. Grundfos
6. Paco
7. Liberty Pumps
8. Bell & Gossett

- B. Description:

1. Provide all bronze construction submersible duplex sump pumps, power cord of length required, mercury float switches, strap mounted, for pump on, pump off, 2 pump on high water alarm, remote mounted duplex pump panels with H.O.A. switch for each pump, power to pump indicating light, push to test buttons, 24 VAC control circuit, alternator, necessary relays, starters, disconnect for each pump, high water audible and visual alarm, phase protection for three phase motors two pump control and NEMA 12 enclosure.
2. Provide fiberglass basin with required inlets, gas tight gasketed steel cover with grommeted openings for piping and wiring and 24" gas tight manhole.

- C. Schedule: See Drawings

2.6 SEWAGE EJECTORS

- A. Acceptable Manufacturers:

1. Weil Pump Company ("Reverse Flow")
2. Federal Pump Corp ("Fed Flush")
3. Hydromatic
4. Grundfos
5. Zoeller
6. Liberty Pumps
7. Bell & Gossett

B. Description:

1. Provide submersible duplex vertical sewage ejectors cast iron impeller, casing and discharge flange, electric motor driven, overflow fitting, control and check valve, and submersible mercury float switches mounted on rigid round suspension rod. NEMA 4 junction box and necessary mounting brackets.
2. Provide fiberglass basin, with gas tight steel (gasketed) cover and grommets cable openings, control panel to house starters, disconnects, alternator, thru the door non-fused disconnects, overload relays, audible and visual high water alarm, pump running lights, factory wired with terminal strip for final wiring, junction box for float controls, floats, float anchoring rod, H.O.A. selector switch, two pump run control, and necessary wiring and cable.

C. Schedule: See Drawings

PART 3 EXECUTION

3.1 GAS FIRED STORAGE TYPE WATER HEATERS

- A. Set level and plumb, adjust burners to proper flame, set temperature, and verify, to 140°F minimum setting.
- B. Provide an expansion tank as specified in the Drawings.
- C. Coordinate installation of flue, draft diverter and flue accessories with Sheet Metal Contractor, Contractor for Section 235100 - Breechings, Chimneys, Stacks and Flues.
- D. Provide ASME temperature and pressure relief valve with full size discharge piped and air gapped to nearest floor drain or other approved receptacle.
- E. Provide hose and drain valve, mixing valve, blending chamber, shut off valves and dielectric connections as required and appropriate.
- F. Provide gas connection with gas valve, dirt leg and cap, pressure regulator and pilot control in accordance with Section 231123 – Natural Gas System.
- G. Sealed combustion water heaters installed in a negative pressure room will require a ¼" vinyl hose run from the pressure switch to the outdoor atmosphere.

3.2 DOMESTIC HOT WATER STORAGE TANK

- A. Provide structural 2" dia schedule 40 black steel welded pipe stand with 2" pipe cross bracing, 6" x 6" x 1/8" steel leg support plates, 3" wide rolled steel (to tank diameter) saddles with 1/8" plate stiffeners, 3" wide x 1/4" thick neoprene pads between saddles and tank.
- B. Set stand level and absolutely plumb, slope tank slightly using saddles as shim mechanism, to drain valve at one end of tank to facilitate complete draindown.
- C. Provide unions and gate valves for complete isolation of the tank from the system.
- D. Provide relief valve with drain extension air gapped to appropriate receptacle.

- E. Tank tapplings shall be provided as detailed or appropriate, ASME welded tank flanges or nipples.

3.3 DIGITAL MIXING VALVE MANIFOLD

- A. Follow all manufacturer's installation recommendations.
- B. Set leaving water temperature to 120°F.

3.4 SUMP PUMPS AND SEWAGE EJECTORS

- A. Coordinate electrical power and control wiring, panel mounting and remote and local alarm systems wiring with Division 26 Contractor in accordance with Section 230529 - Basic Mechanical Materials and Methods.
- B. Provide sumps and basins level and plumb, all openings thru basin or cover to be gas tight, provide unions, valves and checks as appropriate. Note: pump discharge check valves to be non slam type, tilting disc or pilot operated 45 degree swing design. Lift type or spring operated types will not be allowed.
- C. Operating floats shall be tied to vertical float rod and shall not swing free in basin.
- D. Provide pump power cords of sufficient length to exit basin and connect to power source above floor outside of basin area.
- E. Mount control panel and alarm panel, on walls secured tightly and permanently.

END OF SECTION 224450

SECTION 230080
SELECTIVE MECHANICAL DEMOLITION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
1. Demolition and removal of selected portions of building or mechanical systems.
 2. Salvage of existing items to be reused or recycled.
- B. Related Sections include the following:
1. Section 015000 - Temporary Facilities and Controls
 2. Section 017419 - Construction Waste Management and Disposal
 3. Section 024119 - Selective Structure Demolition
 4. Section 024296 - Historic Removal and Dismantling
 5. Section 211000 - Fire Protection
 6. Section 230500 - Basic Mechanical Requirements
 7. Section 230529 - Basic Mechanical Materials and Methods
 8. Section 233300 - Ductwork and Accessories

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and reinstalled.
- B. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- C. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed or removed and reinstalled.

1.4 SUBMITTALS

- A. Schedule of Selective Demolition Activities: Indicate the following:
1. Detailed sequence of removal work, with starting and ending dates for each activity.
 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 3. Coordination for shutoff, capping, and continuation of utility services.
 4. Use of elevator and stairs.
 5. Means of protection for items to remain and items in path of waste removal from building.

1.5 PROJECT CONDITIONS

- A. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
1. Hazardous materials will be removed by Owner before start of the Work.
 2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Owner will remove hazardous materials under a separate contract.
- B. Storage or sale of removed items or materials on-site is not permitted.

- C. Utility Service: Maintain existing utilities in service and protect them against damage during selective demolition operations.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- B. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

3.2 UTILITY SERVICES AND MECHANICAL SYSTEMS

- A. Existing Services/Systems: Maintain all services and systems and protect them against damage during selective demolition operations.

3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Comply with requirements for access and protection specified in Section 015000 - Temporary Facilities and Controls.
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people.
 - 1. Comply with requirements of Section 017419 - Temporary Facilities and Controls.

3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Remove existing mechanical systems only to the extent required and as indicated. Use methods required to complete the Work within limitations of governing regulations.
- B. Removed and Reinstalled Items:
 - 1. Clean items to functional condition adequate for intended reuse.
 - 2. Protect items from damage during transport and storage.
 - 3. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- C. Existing Items to Remain: Protect construction to remain against damage and soiling during selective demolition.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC SYSTEMS

- A. Piping includes: Pipe, fittings, valves, accessories, hangers and insulation.
 - 1. Where existing piping is to be removed:
 - a. Piping shall be drained, disconnected, removed and capped at an active main.
 - b. Piping not to remain in use shall be removed completely.
 - 2. Where existing piping is to be relocated:
 - a. Piping shall be drained, disconnected and removed as shown.
 - b. Hangers may remain if they are to be reused for reinstallation.
 - c. Piping shall be stored for reinstallation.
- B. Ductwork includes: Ductwork, fittings, dampers, registers, grilles, diffusers, accessories, hangers and insulation:
 - 1. Where existing ductwork is to be removed:
 - a. Ductwork shall be disconnected, removed, and capped at an active main.
 - b. Ductwork not to remain in use shall be removed completely.
 - 2. Where existing ductwork is to be relocated:
 - a. Ductwork shall be disconnected and removed as shown.
 - b. Hangers may remain if they are to be reused for reinstallation.
 - c. Ductwork shall be stored for reinstallation.
- C. Where piping or ductwork to be removed is concealed in construction it may be abandoned in place if capped at both ends and approved by the Owner and the Architect.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be reused, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage.
 - 3. Comply with requirements specified in Section – 017419 Construction Waste Management and Disposal.
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.7 CUTTING AND PATCHING

- A. All necessary cutting and patching shall be done by the General Contractor.
- B. Removal and replacement of suspended ceilings necessary for selective demolition of mechanical systems shall be done under this section.

END OF SECTION 230080

SECTION 230500
BASIC MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Basic requirements common to the work in general of Division 21/22/23 and other Divisions and Sections of the Specification where referenced.
- B. Provide, unless specified otherwise, all labor, materials and equipment necessary for completely finished and operational mechanical systems described and specified under Division 21/22 and other Sections of this Division 23.
- C. Provide all minor incidental items such as offsets, fittings, and accessories required as part of the work even though not specified or indicated.
- D. Inspection: Inspect work preceding or interfacing with work of Division 21/22/23 and report any known or observed defects that affect the Work to the Construction Manager/General Contractor. Do not proceed with the work until defects are corrected.
- E. Existing Utilities are indicated as accurately as possible on the Drawings. Close openings and repair damage in acceptable manner to utilities encountered. This Contractor shall be responsible for field surveying all aspects of existing conditions prior to bid date. Change orders will not be issued for a failure to review existing conditions which affect Division 21/22/23 work.

1.2 RELATED WORK

- A. Requirements: Provide Basic Requirements in accordance with the Contract Documents.

1.3 UTILITIES, EXTENSIONS, CONNECTIONS AND FEES FOR WATER AND SEWER

- A. Provide all building services extensions and connections to off-site and on-site utilities.
- B. Sewer connection charges, typically based on fixture units, that in principle allow the right to obtain the sewer services from the utility will be arranged and paid for by the Division 23 Contractor.
- C. Water system development fees, typically based on meter size, that in principle allow the right to obtain the water services from the utility will be arranged and paid for by the Site Utilities Contractor.
- D. Sewer tap fees as they are known to the trade and are the charges for actual materials and labor for tapping, inspection and recording of the tap shall be arranged and paid for by the Site Utilities Contractor.
- E. Water tap fees as they are known to the trade and are the charges for actual materials and labor for tapping, inspection and recording of the tap shall be arranged and paid for by the Site Utilities Contractor.
- F. In the event that the serving utility company installs their own taps, service, meters, etc., all costs imposed by this action shall be paid for by the Division 23 Contractor.

Extensions from termination points to connection with building services and systems will be the responsibility of the Division 23 Contractor.

- G. Be responsible for all pads, vaults, manholes, manhole covers, meter enclosures, valves, services boxes, and the like, all in conformance with requirements of the serving utility company.
- H. In the event that the water service to the building is a combination domestic and fire protection service, the responsibility of said "combination service" to the point of domestic connection shall be that of a licensed Fire Protection Contractor, including tap, valves, excavation, backfill, compaction and meters, if any. After point of domestic connection, responsibility for separate fire and domestic services is with appropriate trades including all labor and materials as herein before mentioned.
 - 1. Contractor shall coordinate with other trades all interface piping and types of connections to be provided for interface.
 - 2. Provide fire hydrant, auxiliary gate valve, tapping sleeve and valve or tee, service boxes, and anchor or swivel couplings, thrust blocks, deadmen, rods, and the like, all in conformance with the requirements of serving utility company.

1.4 REFERENCES

- A. General:
 - 1. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
 - 2. The date of the standard is that in effect at the date of the Contract Documents, except when a specific date is specified.
 - 3. When required by individual Specification sections, obtain copy of standard. Maintain copy at job site during work until substantial completion.

- B. Schedule of Referenced Organizations: The following is a list of the acronyms of organizations referenced in these Specifications:

ADC	Air Diffusion Council 1000 E. Woodfield Rd. Schaumburg, IL 60173 www.flexibleduct.org
AGA	American Gas Association 400 No. Capitol St. N.W. Washington, DC 20001 www.aga.org
AMCA	Air Movement and Control Association 30 West University Drive Arlington Heights, IL 60004 www.amca.org

ANSI	American National Standards Institute 1819 L Street N.W. Washington, DC 20036 www.ansi.org
ARI	Air Conditioning and Refrigeration Institute 4301 No. Fairfax Drive. Arlington, VA 22203 www.ari.org
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers 1791 Tullie Circle, N.E. Atlanta, GA 30329 www.ashrae.org
ASME	American Society of Mechanical Engineers Three Park Avenue New York, NY 10016 www.asme.org
ASPE	American Society of Plumbing Engineers 8614 W. Catalpa Ave. Chicago, IL 60656 www.aspe.org
ASSE	American Society of Sanitary Engineering 901 Canterbury Westlake, OH 44145 www.asse-plumbing.org
ASTM	American Society for Testing and Materials 100 Barr Harbor Dr. West Conshohocken, PA 19428 www.astm.org
AWS	American Welding Society 550 N.W. LeJeune Rd. Miami, FL 33126 www.aws.org
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235 www.awwa.org
CDA	Copper Development Association 260 Madison Avenue New York, NY 10016 www.copper.org

CISPI	Cast Iron Soil Pipe Institute 5959 Shallow Ford Rd., Suite 419 Chattanooga, TN 37421 www.cispi.org
CS	Commercial Standard of NBS (U.S. Dept. of Commerce, National Institute of Standards and Technology) Government Printing Office Washington, D.C. 20402
CTI	Cooling Technology Institute 530 Wells Fargo Drive Houston, TX 77090 www.cti.org
HI	Hydraulic Institute 6 Campus Drive First Floor North Parsippany, NJ 07054 pumps.org
ICC	International Code Council 5203 Leesburg Pike, Suite 600 Falls Church, VA 22041 www.intlcode.org
IAPMO	International Association of Plumbing and Mechanical Officials 20001 E. Walnut Drive South Walnut, CA 91789 www.iapmo.org
NEBB	National Environmental Balancing Bureau 8575 Grovemont Circle Gaithersburg, MD 20877 www.nebb.org
NEC	National Electric Code (of NFPA)
NEMA	National Electric Manufacturer's Association 1300 N. 17 th Street Rosslyn, VA 22209 www.nema.org
NFPA	National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincey, MA 02269 www.nfpa.org

NSF	NSF International 789 No. Dixboro Rd. Ann Arbor, MI 48113 www.nsf.gov
OSHA	Occupational Safety Health Administration (U.S. Dept. of Labor) Government Printing Office Washington, D.C. 20402 www.osha.gov
PDI	Plumbing and Drainage Institute 45 Brystal Drive South Easton, MA 02375 www.pdionline.org
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association 4201 Lafayette Center Drive Chantilly, VA 20151 www.smacna.org
UL	Underwriters Laboratories, Inc. 333 Pfingston Rd. Northbrook, IL 60062 www.ul.com

1.5 DEFINITIONS

- A. Specification Language Explanation: These Specifications are of abbreviated, simplified or streamlined type and include incomplete sentences. Omissions of words or phrases such as "the Contractor shall", "in conformity therewith", "shall be", "as noted on the drawings", "a", "the", are intentional. Supply when "NOTE" occurs on Drawings. Supply words "shall be" or "shall" by inference when colon is used with sentences or phrases. Supply words "on the Drawings" by inference when "as indicated" is used with sentences or phrases. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of the Contract Documents so indicates.
- B. Furnish: Except as otherwise defined in greater detail, term "furnish" is used to mean supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.
- C. Install: Except as otherwise defined in greater detail, term "install" is used to describe operations at Project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.
- D. Provide: Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.

- E. Indicated: The term "Indicated" is a cross-reference to graphics, notes or schedules on Drawings, to other paragraphs or schedules in the Specifications, and to similar means of recording requirements in contract documents. Where terms such as "shown", "noted", "scheduled", and "specified" are used in lieu of "indicated", it is for purpose of helping reader locate cross-reference, and no limitation of location is intended except as specifically noted.
- F. General Contractor: The term "General Contractor" used in Division 23 and elsewhere in the Contract Documents means the party with whom the Owner has executed the Owner-Contractor Agreement.
- G. Approved Equal: Except as otherwise defined in greater detail, term "approved equal" means that any materials, equipment, work procedures and techniques shall be either addressed on the drawing, specifications or addendum by manufacturer or by detailed material description. When brand names are referenced it implies that only the manufacturers listed are approved. All approved material, equipment, work procedures, and techniques will be noted in the specifications, drawings, or by addendum prior to bid date. Items not approved in this manner will not be considered.

1.6 QUALITY ASSURANCE

- A. Quality Control:
 - 1. Materials and apparatus required for the work to be new and of first-class quality; to be furnished, delivered, erected, connected, and finished in every detail; and to be so selected and arranged so as to fit properly into the building spaces. Where no specific kind or quality of material is given, a first-class standard article shall be furnished.
 - 2. Furnish the services of an experienced superintendent, who will be constantly in charge of the installation of the work, together with all skilled workmen, fitters, metal workers, certified welders, plumbers, millwrights, sprinkler fitters, drain layers, helpers, and labor required to unload, transfer, erect, connect, adjust, start, operate and test for each system.
 - 3. Unless otherwise specifically indicated, equipment and materials to be installed in accordance with the recommendations of the manufacturer. This includes the performance of tests as recommended by the manufacturer.
- B. Proof of Performance:
 - 1. Division 23 Contractor shall provide proof of performance certification of all Mechanical Equipment and Systems to demonstrate that all Mechanical Equipment and Systems are operating to the intent of the design. This proof of performance shall include, but shall not be limited to, actual demonstration of all temperature/pressure control loops, operation of all heating/cooling equipment and other required tests upon request by the Engineer or Owner. A signed certificate from the piping, sheet metal, control, and balancing subcontractors stating that they have personally checked the operation of all equipment and control loops and that everything under their subcontract is operating as specified. These certificates shall be furnished to the 230593 Contractor for inclusion in the Operation and Maintenance Manual.

1.7 REGULATORY REQUIREMENTS

- A. Execute work per Underwriters, Public Utility, Local and State Codes, Ordinances and applicable regulations. Obtain and pay for required permits, inspections, and certificates. Notify Architect of items not meeting said requirements.
- B. Comply with editions of all applicable codes, ordinances, and regulations in effect at the time of bid opening including but not necessarily limited to the following:
 - International Mechanical Code
 - International Plumbing Code
 - International Fuel Gas Code
 - International Energy Conservation Code
 - State Department of Health Requirements
 - State Energy Code
 - National Fire Protection Association Standards
 - International Fire Code
 - International Building Code
 - National Electrical Code NFPA-70
 - State Boiler Code
 - Jurisdictional County Health Department
 - Jurisdictional City Wastewater Management Division or District
 - Jurisdictional City Water Department
 - Jurisdictional Water Conservation Standards
- C. If discrepancies occur between the Contract Documents and any applicable codes, ordinances, acts, or standards, the most stringent requirements shall apply.
- D. Where hourly fire ratings are indicated or required, provide components and assemblies meeting requirements of the IBC, and listed by Underwriters Laboratories, Inc.

1.8 SUBMITTALS

- A. Submit items to Commissioning Agent for review.
- B. Submit Samples, Shop Drawings and Product Data as required by various Sections of Division 23 in accordance with The General Conditions of the Contract. The Contractor agrees that these Submittals processed by the Engineer are not Change Orders; that the purpose of these Submittals by the Contractor is to demonstrate to the Engineer that the Contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use. Contractor further agrees that if deviations, discrepancies, or conflicts between these Submittals and the Contract Documents in the form of design drawings and specifications are discovered either prior to or after these Submittals are processed by the Engineer, the Design Drawings and Specifications shall control and shall be followed.

- C. The submittals shall be submitted in a single package with all mechanical equipment for the project enclosed. The submittals shall be enclosed in a stiff back, 3-ring binder. All mechanical equipment shall be separated with tabbed index cards with an indexed legend provided in the front of the binder. In the event submittals are submitted in electronic format, the submittal shall be in the form of a single PDF file in which all equipment has been electronically bookmarked and all bookmarks have been identified using the equipment tags used on the drawings. Individual PDF files for separate pieces of equipment or specification sections will not be accepted.
- D. Test Reports: Submit certified test reports as required by various Sections of Division 23 showing compliance in accordance with General Conditions of the Contract. Signed copies shall be included in the Operation and Maintenance Manual.
- E. Operating Instructions and Maintenance Data: Prepare and submit printed operating instructions and maintenance data in accordance with Operating and Maintenance Data paragraph in this Section.
- F. Submittals will be reviewed and marked as follows:
 - 1. No Exceptions Taken: No action required.
 - 2. Make Corrections Noted: Correct the submittals per notes by engineer and submit new copies of submittal to contractor for project records. Do not resubmit to engineer.
 - 3. Rejected: Equipment as submitted does not meet requirements of contract documents. Revise and/or clarify per comments and resubmit to engineer.
 - 4. Submittal Not Requested: Submittal not required per specification. Submittal returned with no review.
- G. Note that the submittal review process does not relieve Contractor of responsibility for ensuring that submitted items satisfy all requirements of the Contract Documents.
- H. Site Condition and Coordination:
 - 1. Before any ductwork is fabricated or equipment installed and before running and/or fabricating any lines of piping or ductwork, the Contractor shall provide Architect and Engineer 1/4" scale drawings of all mechanical rooms and main access walkways coordinated with all trades with submitted equipment and verify all other areas to assure himself that they can be run and installed as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work and maintain access walkways are clear for maintenance.

1.9 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Substitutions and Prior Approvals: Substitutions and prior approvals will be acceptable only when the proposed substitute has been submitted to the Engineer and approved through an addendum or change order. Request for prior approval shall be submitted a minimum of 10 calendar days prior to bid.
- B. Some materials and equipment are specified by manufacturer and catalog numbers. The manufacturer and catalog numbers are used to establish a degree of quality and style for such equipment and material.

- C. NOTE: When alternate or substitute materials and equipment are used Division 23 Contractor shall be responsible for engineering/redesign costs, space requirements, configurations, performance, changes in bases, supports, structural members and openings in structure, electrical changes and other apparatus and trades that may be affected by their use. Notification of General Contractor and other affected subcontractors shall be the responsibility of the Division 23 Contractor.

1.10 PROJECT RECORD DOCUMENTS

- A. General: Comply with Division 1.
- B. Job Site Documents: Maintain at the job site, one record copy of the following:
1. Drawings
 2. Specifications
 3. Addenda
 4. Reviewed Product Submittals and Shop Drawings
 5. Field Test Records
- Do not use record documents for construction purposes. Maintain documents in clean, dry legible condition, apart from documents used for construction.
- C. Record Information: Label each document "Record Document". Mark information with red ink. Keep each record current. Do not permanently conceal any work until required information is recorded.
- D. Record following information on Drawings:
1. Horizontal and vertical location of underground utilities to be dimensioned from column lines.
 2. Dimensioned location of internal utilities and appurtenances concealed in construction.
 3. Field changes of dimension and detail.
 4. Changes by change order or field order.
 5. Details not on original contract drawings.
 6. Manufacturer, trade name, catalog number and supplier of each product and item of equipment actually installed shall be indicated on equipment schedules.
- E. Record the following information on Specifications:
1. Changes by change order or field order.
 2. Other matters not originally specified.
- F. Shop Drawings: Maintain shop drawings as record documents recording changes made after review as specified for drawings above.
- G. Submittal: At completion of project, deliver record documents to Owner's representative and transmit a copy of signed receipt from Owner to the Engineer.

1.11 OPERATING AND MAINTENANCE DATA

- A. The "Operating and Maintenance Manual" (O & M) is a bound compilation of descriptive drawings and data which identify equipment installed at the project site and detail the procedures and parts required to maintain and repair the equipment. Copies of final reviewed submittals shall be included for all equipment items.
- B. Five sets of bound manuals will be required for this project. These are to be submitted for approval to the Project Manager. Five electronic versions of the manuals are also required, as described in Paragraph I below.
- C. Organization of the manuals shall follow the recommendations in ASHRAE Guideline current edition.
- D. Enclose the material in rigid 3-ring or metal post binders and submit to the Project Manager at the completion of the project. Binders shall be Buckram or metal post binders or prior approved equal with block lettering. Simple binders with slide-in cover sheets are not acceptable. Sheet size shall be 8-1/2" x 11" with expandable metal capacity as required for the project. The number of binders forming one O & M Manual shall be based on a maximum limit of 4 inches. The following information shall appear on the front cover and backbone:
 - 1. "Operation and Maintenance Manual"
 - 2. Project Name (and volume number if more than one volume)
 - 3. Project number
 - 4. Building name, number, and street address
 - 5. Architect's name
 - 6. Engineer's name
 - 7. General Contractor's name
 - 8. Mechanical Contractor's name

* Items "6" through "9" need not be printed on the backbone.
- E. EPages are to be standard 8-1/2" x 11" sheets, or 11" x 17" folded to fit the 8-1/2" x 11" sizes.
- F. The manual shall include the following:
 - 1. Alphabetical list of all system components including the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year's operation.
 - 2. Operating instructions for complete system, including emergency procedures for fire or failure of major equipment and procedures for normal starting/operating/shutdown and long-term shutdown
 - 3. Maintenance instructions, including valves, valve tag and other identified equipment lists, proper lubricants and lubricating instructions for each piece of equipment and necessary cleaning/replacing/adjusting schedules.
 - 4. All test reports and proof of performance certificates.

5. Manufacturer's data and instruction sheets for each piece of equipment, marked to indicate the plan symbol, model, number, and options installed for each item of equipment furnished and installed on the project. These data sheet shall be accompanied by reviewed submittals that had no exceptions taken to them. Provide original printed material in each book, faxes are NOT acceptable. The serial numbers of each item of equipment installed are to be listed with the model numbers and plan symbols.
 - a. Installation instructions.
 - b. Drawings and specifications (final shop drawings).
 - c. Complete parts lists, and a source of supply for each piece of equipment, marked with model, size, and plan symbol.
 - d. A copy of the reviewed submittals for each piece of equipment, with any/all corrections identified during the submittal process made to the final submittal documents.
 - e. Performance curves and capacity data, marked with model number, size, and plan code.
 - f. Complete "as-builts" wiring and temperature control diagrams. (Shop drawings are not acceptable).
 - g. Lubrication and other preventative maintenance data.
 - h. Equipment warranties.
 - i. The final balance report.
 6. Design Intent Document furnished by Engineer.
 7. Include a Table of Contents and tabbed index dividers.
- G. In addition to the maintenance manual, and keyed to it, the equipment shall be identified and tagged as specified on drawings. Insert a copy of the Equipment List or Equipment Schedules in manual.
1. Identify all starters, disconnect switches, and manually operated controls, except integral equipment switches. Label with permanently applied, legible markers corresponding to operating instructions in the "Maintenance Manual".
 2. Tag all valves per requirements in Section 230529.
 3. Provide a typed tag list or schedule laminated or mounted under plexiglass in the equipment room stating valve ID number, location, service or function of each tagged item, and normal valve position. Insert a copy of tag list in each "Maintenance Manual". Also provide one copy of the list in a plastic closure as manufactured by Seton Name Plant Company, New Haven, Conn; or approved equal. The plastic closure shall include two holes punched at the top, with a brass or nickel grommet in each hole, and an 8" long length of nickel plated bead chain run through the holes, allowing the list to be hung from a wall peg.
 4. Provide a reduced scale drawing of each floor indicating the location of each manual and automatic valve in every HVAC and plumbing piping system and include valve position number and normal valve position (normally open/normally closed) as per Specification Section 230529. Mount all drawings under plexiglass or laminate and mount on equipment room wall.

- H. Division 230593 Contractor shall be responsible for scheduling instructional meetings for maintenance personnel on the proper operation and maintenance of all mechanical systems, using the maintenance manual as a guide. These meetings must be scheduled through the Architect, Construction Manager/General Contractor and far enough in advance so that all necessary personnel can be adequately notified.
 - 1. Submit training certificate to Owner's Representatives at end of training and have certificate signed to indicate adequate training has been received.
- I. Operating and Maintenance Data documents must be provided in digital format as follows:
 - 1. Provide O&Ms in an intuitive format on a CD-ROM or DVD. Electronic manual preparation shall be under the direction of an individual or organization that has demonstrated expertise in the preparation of a comprehensive and complete electronic operation and maintenance manual. Qualifications shall be submitted for approval. One source of procurement used on past projects is Emanuals by Scanitall in Sandy, UT (tel. 801-619-2082). This is the responsibility of the Division 21/22/23 contractor.
 - 2. A single CD or DVD to be authored with the latest edition of Adobe Acrobat, and be in a "non-protected" network accessible format.
 - 3. All information on the CD-ROM or DVD shall be printable on 8.5"x11" or 11"x17" plain paper.
 - 4. Capture images using OCR technology such that the user can key word search for information.
 - 5. Provide a hypertext alphabetical index of all equipment and building products. All hypertext shall be blue in color.
 - 6. Provide 3 copies of the O&M CD-ROM or DVD.

1.12 DELIVERY, STORAGE AND HANDLING

- A. General: Deliver and store materials and equipment in manufacturer's unopened containers fully identified with manufacturer's name, trade name, type, class, grade, size and color.
- B. Protection: Store materials and equipment off the ground and under cover, protected from damage. Maintain caution labels on hazardous materials.
- C. Large Items: Make arrangements with other contractors on the job for introduction into the building of equipment too large to pass through finished openings.
- D. Handling of Materials: Materials shall be handled, sorted and distributed using appropriate handling methods to protect all materials from damage. Dented, rusted, corroded or otherwise damaged materials shall be removed from the project site. Lined ductwork on which the liner becomes wet shall be removed from the project site. Determination of materials deemed unusable or inappropriate for installation shall be made by the Architect/Engineer.

1.13 PROJECT CONDITIONS AND ASBESTOS HAZARD

A. Accessibility:

1. Division 23 Contractor shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of his work. He shall cooperate with Contractors of other Divisions of the Work whose work is in the same space and shall advise the Construction Manager/General Contractor of his requirements. Such spaces and clearances shall, however, be kept to the minimum size required.
2. Division 23 Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include (but not be limited to) valves, shock arrestors, traps, cleanouts, motors, controllers, switchgear, filters, VAV boxes, control valves, balancing valves, and drain points. If required for better accessibility, furnish access doors for this purpose. Minor deviations from Drawings may be allowed to provide for better accessibility. Any changes shall be approved by the Architect/Construction Manager/General Contractor prior to making the change.
3. Division 23 Contractor shall provide the Construction Manager/General Contractor with the exact locations of access doors for each concealed valve, damper, or other device requiring service. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work.

B. Fabrication:

1. Before any ductwork is fabricated and before running and/or fabricating any lines of piping or ductwork, the Contractor shall assure himself that they can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

C. Freeze Protection:

1. Do not run lines in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection. Buried pipe shall be installed minimum 6" below frost depth, unless noted otherwise in the documents.

D. Scaffolding, Rigging and Hoisting:

1. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished; remove same from premises when no longer required.

- E. If Contractor during the course of work observes or suspects the existence of asbestos in the structure or building, Contractor shall promptly notify Owner and Architect/Engineer. Owner shall consult with Architect/Engineer regarding removal or encapsulation of the asbestos material and Contractor shall not perform any work pertinent to the asbestos material prior to receipt of special instructions from Owner through the Architect/Engineer.

1.14 COORDINATION

- A. General: Coordinate and order the progress of mechanical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit.
- B. Coordination with Electrical Work: Section 230529.
- C. Utility Interruptions: Coordinate mechanical utility interruptions with the Owner and the Utility Company. Plan work so that duration of the interruption is kept to a minimum.
- D. Cutting and Patching: Section 230529.
- E. Drawings and Specifications: The Mechanical Drawings indicate the general design and arrangement of lines, equipment, systems, etc. Information shown is diagrammatic in character and does not necessarily indicate every required offset, fitting, etc. Do not scale the Drawings for dimensions. Take dimensions, measurements, locations, levels, etc., from the Architectural Drawings and equipment to be furnished.
- F. Each Division 22/23 subcontractor shall coordinate with all other contractors to make certain that any of his equipment, piping or ductwork which is mounted on isolators or flexibly connected does not become "grounded" by another contractors work (e.g. walls, ceiling, etc.).
- G. Coordinate with all subcontractors to maintain adequate access to all equipment for maintenance and for future replacement of equipment.
- H. Discrepancies: Examine Drawings and Specifications for other parts of the work, and if any discrepancies occur between the plans for the work of this Division and the plans for the work of others, report such discrepancies to the Construction Manager/General Contractor and obtain written instructions for any changes necessary.
- I. Order of Precedence: The precedence of mechanical construction documents are as follows:
 - 1. Addenda and modifications to the Drawings and Specifications take precedence over the original Drawings and Specifications.
 - 2. Should there be a conflict within the Specifications or within Drawings of the same scale, or between the Specifications and the Drawings, the more stringent or higher quality requirements shall apply.
 - 3. In the Drawings, the precedence shall be Drawings of larger scale over those of smaller scale, figured dimensions over scaled dimensions and noted materials over graphic indications.
 - 4. Should there be a conflict in dimensions or locations between Mechanical Drawings and Architectural Drawings, the Architectural Drawings shall have precedence.

1.15 START-UP PROCEDURES

- A. Before start-up, each piece of equipment comprising a part of the system shall be checked for proper lubrication, drive rotation, belt tension, proper control sequence, and any other condition which may cause damage to equipment or endanger personnel.

- B. Insure that all control systems are fully operational in automatic mode. Individually test each control loop to make certain it is operating as intended and is communicating properly with other devices.
- C. If systems are not to continue in use following the start-up procedures, steps should be taken to insure against accidental operation or operation by unauthorized personnel. Provide padlocks on disconnect switches where applicable.
- D. Factory personnel shall be notified as appropriate to start systems requiring their services.
- E. Notify engineer at least 2 weeks prior to the scheduled start-up date of all major mechanical equipment and systems.

1.16 SCHEDULE OF TESTING

- A. Provide testing in accordance with the General Conditions of the Contract.
- B. A schedule of testing shall be drawn up by the Division 23 Contractor in such a manner that it will show areas tested, test pressure, length of test, date, time and signature of testing personnel.
- C. All testing must be performed in the presence of the Architect's/Construction Manager's/General Contractor's representative; his signature for verification of the test must appear on the schedule.
- D. All testing must be performed in accord with the procedures set forth in Division 23 and other Sections of the Specifications where referenced. At completion of testing, the completed schedule shall then be submitted in triplicate to the Architect and a copy shall be forwarded to the 230593 Contractor for inclusion in Operation and Maintenance Manual.
- E. Make all specified tests on piping, ductwork and related systems as specified in this specification.
- F. Make sure operational and performance tests are made on seasonal equipment.
- G. Complete all tests required by Code Authorities, such as smoke detection, life safety, fire protection and health codes.
- H. After test runs have been completed and systems have been demonstrated to be satisfactory and ready for permanent operation, all permanent pipeline strainers and filters shall be cleaned, air filters cleaned or replaced, settings on pressure relief valves properly adjusted, valve and pump packings properly adjusted, belt tensions adjusted, drive guards secured in place, lubrication checked and replenished if required.

1.17 COMMISSIONING

- A. The project will be commissioned by a commissioning agent hired by the owner. Contractor shall assist the commissioning agent and participate in the commissioning process.

1.18 CLEANING AND FINISHING

- A. Provide cleaning in accordance with the General Conditions of the Contract and Division 1.
- B. Cleaning shall include but not be limited to removing grease, dirt, dust, stains, labels, fingerprints and other foreign materials from sight-exposed piping, ductwork, equipment, fixtures and other such items installed under Division 23 of the work. If finishes have been damaged, refinish to original condition and leave everything in proper working order and of intended appearance.
- C. Section 232113 Contractor shall be responsible to certify that all HVAC Piping Systems have been cleaned in accordance with Section 232500 - HVAC Water Treatment whether actually done by the Section 232113 Contractor or by the 232500 Contractor.

1.19 WARRANTIES

- A. Warranty: Provide a written warranty to the Owner covering the entire mechanical work to be free from defective materials, equipment and workmanship for a period of one year after Date of Acceptance. During this period provide labor and materials as required to repair or replace defects. Provide certificates for such items of equipment which have warranties in excess of one year. Submit to the Construction Manager/General Contractor for delivery to the Architect. Include a copy of all warranties in the Operation and Maintenance Manual.
- B. This warranty will be superseded by the terms of any specific equipment warranties or warranty modifications resulting from use of equipment for construction heat or ventilation.
- C. All refrigeration compressors shall have a (4) four year extended warranty from the manufacturer of the equipment in addition to the standard one-year warranty.

1.20 PROJECT CLOSEOUT

- A. Project Observation Reports:

At or near the completion of the construction phase of this project, the Engineer will generate one or more Project Observation Reports for the owner. These reports will list the items of construction observed by the Engineer which are not in compliance with the Contract Documents.

The Mechanical Contractor and/or subcontractors shall certify completion of each listed item in writing and forward copies to the Architect, Engineer and General Contractor. The Engineer will not recommend the payment of retainage until this compliance certification has been received.

Each item on the Project Observation Report shall have a signature/date in the margin of the report indicating completion of that item.

1.21 CERTIFICATES AND KEYS

- A. Certificates: Upon completion of the work, deliver to the Construction Manager/General Contractor one copy of Certificate of Final Inspection.

- B. Keys: Upon completion of work, submit keys for mechanical equipment, panels, etc. to the Construction Manager/General Contractor.

END OF SECTION 230500

**SECTION 230529
BASIC MECHANICAL MATERIALS AND METHODS**

PART 1 GENERAL

1.1 RELATED WORK

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.
- B. Work furnished but not installed by this Contractor:
 - 1. Access doors in accordance with paragraph 2.3 in this Section 230529.

1.2 SYSTEM DESCRIPTION

- A. The work includes, but is not limited to the following:

Materials and methods common to the work in general of Division 23 and other Divisions and Sections of the Specifications where referenced.

1.3 QUALITY ASSURANCE

- A. Welder Qualifications: Welding shall be performed by an ASME Certified welder with current certificate in accordance with ANSI B31.1 for shop and project site welding of piping work. Welder Qualifications:
 - 1. Each welder shall have passed a qualification test within the past 6 months.
 - 2. The test shall be in accordance with the ASME Boiler and Pressure Vessel Code, Section IX, "Welding Qualifications", ASME Section VIII, and ANSI 313.
 - 3. The test report shall certify that the welder is qualified to weld the material to be used at the job site.
 - 4. The Contractor shall submit three copies of each welder's qualification test report to the Project Manager for approval prior to commencing the work. No welder shall be used on the project until so certified.

1.4 REFERENCES

- A. Reference Standards: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:
 - 1. For electrical equipment and products, comply with applicable National Electrical Manufacturers Association (NEMA) Standards, and refer to NEMA Standards for definitions of terminology herein.
 - 2. Comply with National Electrical Code (NEC) NFPA-70 for electrical installation requirements.
 - 3. Certified Pipe Welding Bureau (NCPWB) and American National Standards Institute (ANSI) Code Numbers B31.2, & B31.9 as applicable for welding requirements.
 - 4. Comply with American National Standards Institute (ANSI A13) for identification of piping systems.
 - 5. Comply with American National Standards Institute (ANSI B31.1) Code for Pressure Piping.
 - 6. State of Utah, Division of Facilities Construction and Management Design Criteria.

1.5 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings and Product Data for the following items in accordance with the General Conditions of the Contract:
 - 1. Legend and color of piping and equipment identification.
 - 2. Freeze Protection Systems for Piping and Equipment (Heat Tracing).
 - 3. Proposed access door sizes and locations.
- B. Operating Instructions and Maintenance Data: Submit printed Operating Instructions and Maintenance Data for the following items in accordance with Operating and Maintenance Data Paragraph in Section 230500.
 - 1. Motors.
 - 2. Starters.
- C. Certificates: Before proceeding with the Work, submit to the Architect and Owner, two copies of Certification that the welding work will be done according to ANSI B31.1 by welders who have been tested and whose qualification test sheets are available, attesting to their ability to weld in accordance with the Standard Procedure Specifications as established by the National Certified Pipe Welding Bureau.

PART 2 PRODUCTS

2.1 MOTORS

- A. General: Furnish motors necessary to operate mechanical equipment.
- B. Motor Characteristics: Comply with the following requirements:
 - 1. Variable Speed Drive Compatibility: All motors which are powered through a variable frequency drive shall conform to NEMA MG-1, Part 31 for inverter duty and shall be capable of continuous operation at 20% of nominal speed and shall meet the requirements of the Variable Frequency Drive specification in Section 230810 or Division 26 as applicable.
 - 2. Altitude Deration: Motors to be furnished to maintain specified rated service factor at altitude of project.
 - 3. NEMA Temperature Rating: Rated for 40 deg.C environment for continuous duty at full load, Class B motor temperature rise. Motors for use with variable frequency drives shall be Class F insulated.
 - 4. Starting Capability: Provide each motor capable of making starts as frequently as indicated by the automatic control system.

5. Phases and Current Characteristics: Provide squirrel-cage induction polyphase motors for 3/4 horsepower and larger, and provide capacitor-start single-phase motors for 1/2 horsepower and smaller. One-sixth horsepower and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division 26 and with individual equipment requirements specified in other Sections of Division 23. Provide two separate windings on polyphase two speed motors. Do not purchase motors until power characteristics available at locations of motors have been confirmed, and until rotation directions have been confirmed.
6. Power Factor: All motors rated greater than 1000 watts shall have a Power Factor of not less than 95% under rated load conditions. The 95% PF may be obtained by design of the motor or by providing a capacitor. Capacitors, if provided to obtain the 95% PF, must be switched with the motor. If the motor draws less than 1000 watts at full load, it is excluded from the 95% power factor requirement.
7. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors. Motors shall be selected such that the brake horsepower requirement is not within the service factor at design load.
8. Efficiency: All motors shall be premium efficiency type in accordance with the current State Energy Code, except where a higher efficiency is noted on drawings.
9. Motor Construction: Provide Design "B" motors for general purpose continuous duty and Design "C" motors where required for high starting torque such as the low speed motor on fans with a two-motor drive arrangement. Small motors that are part of packaged equipment may be manufacturer's standard motors meeting Energy Code requirements for efficiency.
 - a. Bearings: Ball or roller bearings with inner and outer shaft seals: regreasable; except permanently sealed where motor is normally inaccessible for regular maintenance. Where belt drives and other drives produce lateral or axial thrust in the motor, provide bearings designed to resist the thrust loading. Refer to individual sections of Division 23 for fractional horsepower light-duty motorized equipment where sleeve-type bearings are permitted.
 - b. Enclosure Type: Except as otherwise indicated, provide open drip-proof motors for indoor use where satisfactorily housed during operation, and provide guarded drip-proof motors where exposed to contact by employees or building occupants. Provide weather-protected Type I for outdoor use, Type II where not housed. Refer to individual Sections of Division 23 for other enclosure requirements.
 - c. Overload Protection: Provide built-in thermal overload protection for each leg of each phase and, where indicated, provide internal sensing device suitable for signaling and stopping the motor at the starter. Thermal overload protectors shall be sized to accommodate the altitude of installation.
 - d. Name Plate: Provide metal nameplate on each motor, indicating full identification of manufacturer, ratings, characteristics, construction, NEMA efficiency, power factor, special features and similar information.
 - e. Motor Connections: Provide conduit connection boxes.
 - f. Motors shall not exceed 80dbA rating when running their full speed and power range.

2.2 STARTERS

- A. Note that some starters are furnished and installed under Division 26. Review electrical plans before bidding.
- B. General: Furnish starters and contactors necessary to operate mechanical equipment motors. **Starter manufacturer shall be the same brand for ALL motors furnished under Division 23.** Approved manufacturers shall be those listed in Division 26 or this specification.
- C. Motor Starter Characteristics: Comply with NEMA standards and NEC. Furnish Type I general purpose enclosures with padlock ears, and with frames and supports for mounting on wall, floor or panel as required. Furnish the type and size of starter recommended by the motor manufacturer and equipment manufacturer for the applicable protection and start-up condition; refer to individual equipment sections for basic load requirements. All starters shall be by the same manufacturer. Only manufacturers approved in and complying with the requirements of the Division 26 contract documents will be accepted.
- D. Manual Control:
 - 1. Furnish maintained-contact push buttons and pilot lights, properly arranged for single-speed or multi-speed operation as indicated.
 - 2. Furnish manual switch and pilot light for motors 1/3 horsepower and smaller, except where interlock or automatic operation is indicated.
- E. Automatic Control:
 - 1. Furnish magnetic starters for motors 1/2 horsepower and larger and for smaller motors where interlock or automatic operation is indicated. Include the following:
 - a. Maximum number of auxiliary contacts available: three or more.
 - b. "Hand-Off-Automatic" switches in starter cover.
 - c. Interlocks, pneumatic switches and similar devices as required for coordination with the control requirement specified in Section 230900-Electronic Controls.
 - d. Built-in 120 volt control circuit transformer, fused from line side, where service exceeds 240 volts.
 - 1) Control circuit conductors to be protected in accord with the National Electrical Code.
 - e. Trip-free thermal overload relays, each phase.
 - f. Externally operated manual reset except on refrigeration compressors which shall have automatic reset. Automatic reset shall be limited to three attempts. If motor fails to start after three attempts, manual reset shall be required.
 - g. Undervoltage release or protection.
 - h. Phase failure/phase reversal protection on all legs.
- F. Weather Protection: Provide weather-proof mounting of magnetic starters for equipment outside of the building.

2.3 ACCESS DOORS

- A. Furnish steel access doors, minimum size required for normal service use or as sized on drawings as manufactured by Inryco/Milcor, where shown on mechanical or architectural drawings, and where required for access to valves, shock absorbers, dampers, mechanical equipment or appurtenances.
- B. Standard Doors:
 - 1. Frames: 16 ga. steel.
 - 2. Panels: 14 ga. steel.
 - 3. Finish: Chemically bonded prime coat of baked enamel.
 - 4. Hinge: Concealed spring hinges openable to 175 degree; removable pins. Provide number of hinges as recommended by manufacturer for size of door.
 - 5. Locking Devices: Flush steel, screwdriver operated, cam type locks. All access doors below 8'-0" in public areas shall be key-operated cylinder lock with two keys. Same key shall open all access doors.
 - 6. Style of doors shall be appropriate for architectural finish at door location. Furnish masonry anchors where required.
- C. Fire Rated Doors:
 - 1. Frames: 16 ga. steel.
 - 2. Panels: Sandwich type, 20 ga. steel sheets, manufacturer's standard insulated core.
 - 3. Finish: Chemically bonded prime coat of baked enamel.
 - 4. Hinge: Continuous type, steel with stainless steel pin.
 - 5. Closer: Automatic closing mechanism.
 - 6. Locking Devices: Self-latching, key-operated cylinder lock with two keys; interior, latch release mechanism.
 - 7. Style of doors shall be appropriate for architectural finish at door location.
 - 8. Fire rated doors shall have components and assemblies meeting requirements of the American Insurance Association, Factory Mutual Insurance Association and listed by Underwriters Laboratories, Inc.
- D. Exact location of access doors shall be as directed by Mechanical Contractor and approved by the Architect. Coordinate with General Contractor and Architect.

2.4 VALVES

- A. General:
 - 1. Provide valves as specified herein and as indicated on the Drawings complete with accessories and attachments as required and appropriate for the pressure/temperature of system.
 - 2. Supply valves for proper pressure ratings determined by the system working pressures at point of use and of proper types for systems and functions indicated.
 - 3. Steam and Condensate System Isolation Valves: Use steam rated ball valves on pipe sizes 2" and smaller. Use gate valves on pipes larger than 2". Use globe valves on manual bypass lines.
 - 4. Provide like type valves of one manufacturer only unless specified otherwise.

5. Plainly and permanently mark valves with manufacturer's name or trademark, pressure rating, both Cold Working Pressure (CWP) and Steam Working Pressure (SWP), as applicable and flow direction when required to prevent improper installation.
6. Mark valves requiring approval by Underwriter's Laboratories (UL) or Factory Mutual Engineering Division (FM) with appropriate markings cast into the valve body.
7. Provide extended necks as appropriate for insulation.

B. Manufacturers:

1. The following manufacturers are acceptable providing the product to be considered is equivalent in every respect to the nomenclature provided by the specified make and model.
 - a. Bronze Valves: Powell, Milwaukee, Crane, Hammond, Nibco.
 - b. Iron Body Valves: Powell, Milwaukee, Traverse City, Kennedy, Iowa, American, Nibco.
 - c. U.L., F.M. Approved or Listed Valves: Nibco, Demco, Pratt, Kennedy, Mission, Milwaukee, Hammond.
 - d. Ball Valves: Hammond, Watts, Jamesbury, Worcester, Milwaukee, Apollo, Powell, Dynaquip, Nibco, Spirax Sarco, FNW.
 - e. Butterfly Valves: Milwaukee, Hammond, Centerline, DeZurik, Fisher, Victaulic, Keystone, Posi-Seal, TEC, Flowseal, Nibco, IFC, FNW, Bray, EBRO.
 - f. Lubricated Plug Valves: Homestead, Nordstrom, Powell.
 - g. Non-Lubricated Eccentric Plug Valves: DeZurik.
 - h. Stop and Drain and Drain Valves: Milwaukee, Hammond, Prier, Nibco or United Brass.
 - i. Gas Cock: Peter Healy or Crane.
 - j. Check Valves: Nibco, IFC, DFT, Crane.

C. Valve Schedule:

1. Standard Bronze Valves - 150 SWP/300 CWP, per ASTM B61/B62. No brass materials will be accepted.
 - a. Check, Gate, and globe with union bonnet and rising stem.
 - b. Sizes 1/8 through 2 inches.
 - c. Schedule:

Plan Code:	G.V.	GL.V.	C.V. *	L.C.V. *
Valve Type:	Gate	Globe	Swing	Lift
Make:	Nibco	Nibco	Nibco	CRANE
Straight Threaded:	T-134	T-235Y	T-433Y	366E
Straight Soldered:	S-134	S-235Y	S-433Y	--
Angle Threaded:	--	T-335Y	--	--
Angle Soldered:	--	--	--	--

* Pressure drop across check valves shall not exceed 1 psi at design flow.

2. Standard Bronze Valves - 300 SWP/600 CWP, per ASTM B61/B62, no brass materials will be accepted.
- a. Gate, globe and check.
 - b. Sizes 1/8 through 2 inches.
 - c. Schedule:

Plan Code	G.V.	GL.V.	C.V. *	L.C.V. *
Valve Type:	Gate	Globe	Swing	Lift
Make:	Nibco	Nibco	Nibco	Crane
Straight Threaded:	T-174-A	T-275-Y	T-473-Y	
Straight Soldered:	--	--	--	366E
Angle Threaded:	--	T-375-Y	--	--
Angle Soldered:	--	--	--	--

* Pressure drop across check valves shall not exceed 1 psi at design flow.

3. Standard Iron Body Valves - 125 SWP/200 CWP.
- a. Gate, globe and check.
 - b. Sizes 2-1/2 through 12 inches.
 - c. Schedule:

Plan Code:	G.V.	OS&Y	GL.V.	C.V. *	W.C.V. *	N.S.C.V. *
Valve Type:	Gate	Gate	Globe	Swing	Weighted	Non Slam
Make:	Nibco	Nibco	Nibco	Nibco	Nibco	CRANE
Straight Threaded:	T-619	T-617-0	--	T-918-B	--	--
Straight Flanged:	F-619	F-617-0	F-718B	F-918-B	F-918BLW	223
Angle Threaded:	----	----	--		----	----
Angle Threaded:	----	----	F-818B	----	----	----

* Pressure drop across check valves shall not exceed 1 psi at design flow.

4. Standard Iron Body Valves - 150 SWP/300 CWP.

- a. Gate, globe and check.
- b. Sizes 2 through 12 inches.
- c. Schedule:

Plan Code:	G.V.	OS&Y	GL.V.	C.V.	N.S.C.V.
Valve Type:	Gate	Gate	Globe	Swing *	Non Slam *
Make:	Nibco	Nibco	Nibco	Nibco	Crane
Straight Threaded:	--	--	--	--	--
Straight Flanged:	F-669	F-667-0	F-768B	F-968B	223
Angle Threaded:	--	--	--	--	--
Angle Flanged:	--	--	F-868B	--	

* Pressure drop across check valves shall not exceed 1 psi at design flow.

5. Standard Iron Body Valves - 250 SWP/500 CWP.

- a. Gate, globe and check.
- b. Sizes 2 through 12 inches.
- c. Schedule:

Plan Code:	G.V.	OS&Y	GL.V.	C.V.	N.S.C.V.
Valve Type:	Gate	Gate	Globe	Swing *	Non Slam *
Make:	Nibco	Nibco	Nibco	Nibco	Crane
Straight Threaded:	--	--	--	--	--
Straight Flanged:	F-669	F-667-0	F-768B	F-968B	223
Angle Threaded:	--	--	--	--	--
Angle Flanged:	--	--	F-868B	--	--

* Pressure drop across check valves shall not exceed 1 psi at design flow.

6. UL and FM Approved Valves.

- a. Gate, check and butterfly.
- b. Sizes all.
- c. Schedule:

Plan Code:	OS&Y	C.V.	W.V.C.	BF.V	D.V.
Valve Type:	Gate	Swing	Wafer	BTFY	Drain
Make:	Nibco	Nibco	Nibco	Demco	Nibco
Straight Threaded:	T-104-0	T-413W	--	--	T-211Y
Straight Flanged:	F-607-0	F-908-W	--	--	--
Wafer:	--	--	KW-900-W	NE-H	--

7. UL and FM Approved Valves - 175 Pound Water.

- a. Post indicator with indicator post.
- b. Sizes 4 through 12 inches.
- c. Schedule:

Plan Code:	P.I.V.	P.I.V.B.F.
Valve Type:	Gate	BTFY
Make:	Nibco	Demco
Straight Flanged:	F-609	NE-H (Wafer)
Mechanical Joint:	M-609	--
Indicator Post Vertical:	NIP-1	Stem extension and gear operator with post indicator U.L. Listed only.
Indicator Post through Wall:	NIP-2	--

8. Underground Valves - 175 Pound Water, American Water Works Association (AWWA).

- a. Gate valves with service boxes.
- b. Sizes (see schedule).

c. Schedule:

Plan Code:	GV & SB	GV & SB
Size/Inches:	3/4 thru 2	2 thru 16
Valve Type:	Oriseal	Gate
Make:	Mueller	Mueller
Model:	H-15201	A-2380-22 or 2380-18
Service Box:	H-10396-86	H-10357
Base:	H-10396-7-8-9 or H-10400	No. 6 Oval
Key:	Stationary rod attached.	A-24610 Furnish one each box.

9. Ball Valve:

- a. Blowout proof stem.
- b. Full port type with appropriate seals and seat, as specified.
- c. Bronze bodies per ASTM B61/B62 or ASTM B-584. No brass material will be accepted.
- d. Stainless steel bodies per ASTM A-351, Grade CF3M.
- e. Schedule:

Plan Code:	B.V.	B.V.	H.V.	S.B.V.
Service:	Balancing	In line control and isolation	Refrigeration	Steam and Steam Condensate
Pressure:	150 SWP/300 CWP	150 SWP/300 CWP	500 CWP	150 SWP
Sizes/Inches:	1/4 thru 2-1/2	1/4 thru 3"	3/8" thru 2 1/8"	1/2" thru 2"
Make:	Nibco	Nibco	Nibco	Nibco
Straight Threaded:	T-580-70-66	T-585-70-66	--	T-595-Y-S6R-66
Straight Solder End:	S580-70	S585-70	S595-Y-66	--
Actuator:	Lever with memory stop	Lever	Lever	Lever
Port:	Standard	Full	Full	full

* Steam ball valve includes a three-piece body, seals rated for steam operating temperatures up to 400°F.

10. Butterfly Valves:

- a. Schedule; standard 150 psi with 150 psi ANSI companion flanges for use where system pressures cannot exceed 200 psig shut off (static) pressure.

Plan Code:	BFV	
Style:	Lugged	
Pressure Rating ANSI Class:	150 minimum	
Body:	ASTM A126 Cast Iron or ASTM A395 Ductile Iron	
Disc:	Aluminum Bronze	
Stem:	316 Stainless	17-4 PH Stainless or 18-8 Stainless
Seat:	EPDM (-40 deg.F to 250 deg.F)	
Actuator:	2" thru 5" Infinite position lever with memory stop. 6" thru 24" Self-locking worm gear with adjustable limit stops, and position indicator. Provide chain wheel and chain where indicated by contract documents.	
Make:	Keystone	
Size:	2"-12"	14"-36
Model:	222	AR2

- b. Schedule: High performance 300 psi with 300 psi ANSI companion flanges for use where system pressures are more than 200 psig but cannot exceed 700 psig shut-off (static) pressure.

Plan Code:	BFV	
Style:	Lug	
Pressure Rating ANSI Class:	300 minimum	
Body:	Carbon steel ASTM A-216	
Disc:	316 stainless steel ASTM A-216	
Stem:	Stainless steel ASTM A564 Type 630 (17-4PH)	
Seat:	Virgin TFE	
Actuator:	3" and 4": Ratchet handle with lock. 6 and over: Worm gear with lock.	
Make:	Flowseal (Mark Controls Corp.)	
Size:	3" and 4"	6" and over
Model:	XX-3L-121TTH-L	XX-3L-121TTH-2

11. Stop Check Valve:

a. Schedule:

Plan Code:	S.C.V.
Pressure:	250 SWP/500 CWP
Size/Inches:	2-1/2 thru 10"
Make:	Crane
Straight Flanged:	28E
Angle Flanged:	30E

12. Eccentric Plug Valve:

a. Schedule:

Plan Code:	E.P.V.	E.P.V.
Pressure:	175 lb. CWP	175 lb. CWP
Size/Inches:	1/2 thru 3	4 thru 8
Make:	DeZurik	DeZurik
Model:	400	100
Actuator:	483-487	159 w/Memory Stop
Ends:	Threaded	Flanged

13. Gas Valves:

a. Gas cock and lubricated plug.

b. Schedule:

Plan Code:	G.C.K.	L.P.V.	L.P.V.	G.B.V.
Pressure:	100 PSI Air	200 lb. CWP	200 lb. CWP	250 PSI LP-Gas
Size/Inches:	1/2 thru 1	1/2 thru 3	4 thru 12	1/4" thru 3"
Make:	Peter Healy	Walworth	Walworth	Apollo
Model:	1500-F	1700	1707-F	80-100
Actuator:	None	E-2	Wrench as required	1/4 turn
Ends:	Threaded	Threaded	Flanged	Threaded

14. Specialty Valves:
- a. Petcock, stop and drain, drain, needle.
 - b. Schedule:

Plan Code:	PTK	S&D.V.	D.V.	N.V.
Type:	Petcock	Gate	Ball	Needle
Pressure:	250 LB.	125 LB.	125 LB.	200 LB.
Size/Inches:	1/8	1/2 and 3/4	3/4	1/8 thru 3/4
Make:	Powell	Nibco	Apollo	Jenkins
Model:	922	76 or 726	78-104	743G
Ends:	Threaded	Threaded or Soldered	Threaded and Hose End Adaptor	Threaded

2.5 PIPE HANGERS, SUPPORTS, AND ACCESSORIES PROTECTION

A. General:

1. Provide hangers, rods, clamps, brackets, attachments, inserts, bracing, nuts, coach screws, eye bolts, clips, plates, and washers as required for appropriate installation for building structure provided.
2. All hangers and accessories shall be manufactured by one manufacturer for compatibility of all components.
3. All hangers, attachments, and accessories shall be provided with a certified manufacturer's safety factor of five (5).
4. All hangers, attachments and accessories shall comply with the following:
 - a. Safety factor of 5 (actual load vs. ultimate load).
 - b. National Fire Protection Association (NFPA) (except as amended by provisions of this Specification for minimums) and as applicable.
 - c. Factory Mutual Engineering Division (FM) as applicable.
 - d. Manufacturers Standardization Society (MSS).
5. Support and positioning of piping shall be by means of engineered methods that comply with IAPMO PS 42-96.

B. Material:

1. Hangers in contact with steel, iron, cast or ductile iron shall be hot dipped galvanized or cold galvanized with "Galviline by ZRC" cold galvanized compound only to a thickness of not less than 3.0 mil (.003 inches). "Galviline by ZRC Worldwide, Marshfield, MA. Tel: (800) 831-3275, www.zrcworldwide.com" or equal.
2. Hangers in contact with copper piping shall be copper clad or provided with heavy density felt (20 oz.) pad permanently attached to the hanger and placed so as to prevent direct contact between pipe and hanger. Felt shall be mildew and moisture rot-proof. Heavy polyvinyl chloride coating on hanger, 5 mil thickness minimum will be acceptable in lieu of felt.

3. Hangers in contact with "plastic" or "glass" piping shall be galvanized in accordance with Sub-paragraph B-1, above and padded in accordance with Sub-paragraph B-2, above.
4. Hangers for insulated piping shall be sized to accommodate the insulation. Provide with insulation shields or insulation saddles* as applicable and appropriate and in accordance with the following schedule:

Nominal Pipe or Tubing Size	Shield Length	Shield Gauge Thickness	Material
½" thru 3"	12"	18	Galvanized
4"	12"	16	Galvanized
5"	15"	16	Galvanized
6"	18"	16	Galvanized
8"	24"	--	B-line (B3160-3165)
over 8"	36"	--	B-line (B3160-3165)

- * Insulation inserts between piping and shield shall be furnished by 230700 Contractor for appropriate pipe size and insulation thickness for all insulated piping requiring a vapor barrier.
5. Provide swivel ring hangers similar and equivalent to B-Line B-3170, 3170CT, and 3170C for pipe sizes 1/2" thru 8".
 6. Clevis type hangers may, at the Contractors option, be provided when similar and equivalent to B-Line B-3100, and 3100C.
 7. Roller type hangers shall be used on all steam piping 4" and larger and when appropriate shall be equivalent to B-Line B-3110 black steel with cast iron roller. Provide insulation saddles for all roll-type hangers, B-Line B3160-3165. Calcium silicate inserts, in conjunction with insulation saddles shall be provided on all steam piping.
 8. Beam and bar joist clamps shall be appropriate for attachment locations, top beam, bottom beam, etc., and provided with retainer rods, clips or straps as required.
 9. Hanger spacing and minimum rod sizes shall be based on the applicable Mechanical and Plumbing Codes for the type of piping installed.
 10. Riser clamps shall be provided on all vertical risers at each floor and shall conform to materials and protective coatings or pads as specified in Paragraph B of this Article 2.05. Clamps shall be similar and equivalent to B-Line B-3131 and B-3148.
 11. Provide concrete inserts where required in flat slab construction similar and equivalent to B-Line B-22-1 Series 2000 lbs. per foot load capacity and spaced per hanger spacing schedule (sub-paragraph B-9 above) provide all accessories and nuts required.

12. Trapeze hangers shall be constructed of channel similar and equivalent to B-Line Series B-11 thru B-72 as appropriate complete with pipe clamps, nuts, rollers etc., as required. Channel to bear 5 times actual weight of all piping on trapeze system with minimum deflection. (.01 inch maximum). At a minimum, install pipe clamps on every other trapeze hanger, and where required to comply with seismic restraint design.
13. Wall brackets shall be fabricated "knee" brackets conforming to requirements of sub-paragraph B-12 above and made up with B-Line Series B-11 thru B-72 channel. Angle clips may be used in wood joist construction when similar and equivalent to B-Line B-3060 or 3061.
14. Hangers attached to wood construction shall be attached by use of eye bolts, coach screws or lag bolts when load bearing ratings maintain a safety factor of 5.
15. All other means of support i.e., special construction, pipe stands, earthquake bracing, sway bracing, etc., shall be provided as required and in conformance with jurisdictional authority and these Contract Documents, submit all special or required support and bracing systems for review by the Architect/Engineer prior to installing any item.
All vertical refrigeration suction and hot gas, and all steam piping shall be provided with insulation shields and calcium silicate inserts at each support location.
16. All piping systems exposed to motorized traffic shall be fully protected by installation of concrete-filled pipe bollards. Bollards shall be cleaned and painted as directed by the Architect.
17. For plenum applications use pipe supports that meet ASTM E-84 25/50 standards.

C. Acceptable Manufacturers:

1. Manufacturers acceptable to this Specification are as follows, all other manufacturers must submit for acceptance.
 - a. B-Line
 - b. Fee & Mason
 - c. Grinnell
 - d. Hubbard Enterprises/HOLDRITE
 - e. P.H.D.
 - f. Michigan
 - g. Tolco
 - h. MAPA
 - i. Hilti
 - j. Caddy

2.6 IDENTIFICATION MATERIALS FOR PIPING AND EQUIPMENT

A. Materials for identification shall be as follows:

1. Metal Tags: Round brass discs, minimum 1-1/2" diameter with edges ground smooth. Each tag shall be punched and provided with brass chains for installation.
2. Engraved Nameplates: Fabricate from plastic sheet stock of sufficient thickness to allow engraved lettering in contrasting color. Attach nameplates to equipment with screws.

3. Painted Stencils: Of size and color per ANSI A13.1 using clean cut letters and oil base paint. Paint material shall comply with Architectural Painting Specifications. See Part 3 for legend and size for Stencils.

***** OR *****

3. Pressure Sensitive Markers: Brady Type 350 flexible vinyl film identification markers and tape, with legend, size and color coding per ANSI A13.1. or approved equal.

***** OR *****

3. Semi-rigid Plastic Identification Pipe Markers: Section Setmark with legend, size and color coding per ANSI A13.1 Direction of flow arrows are to be included on each marker, unless otherwise specified.
 - a. Setmark Type Snap-Around markers to be used on diameters 3/4" thru 5".
 - b. Setmark Type Strap-Around markers to be used on diameters 6" or larger.

Insulation or Pipe Diameter	Length of Color Field	Size of Letters
3/4" to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
over 10"	32"	3-1/2"
Ductwork and Equipment	NA	2-1/2"

2.7 FREEZE PROTECTION SYSTEMS FOR PIPING AND EQUIPMENT (HEAT TRACING)

A. General:

1. Provide freeze protection for all water, sewer, sumps, tanks, pumps, equipment drains, etc., where piping and equipment are subject to ambient temperatures of less than 35 deg.F, and as indicated on Contract Drawings.
2. Approved Manufacturers: Raychem, Thermon, Heat Trace Solutions.
3. Freeze protection shall consist of electrical self regulating semi-conductive "core" heat cable complete with all accessories including but not limited to an adjustable thermostat sensing the pipe or vessel contents temperature in lieu of ambient sensing, and contactors to enable power to the heat cable when temperature is below thermostat setpoint.

4. The self-regulating heater shall consist of two (2) 16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heater to be crossed over itself without overheating, to be used directly on plastic pipe, and to be cut to length in the field. The heater shall be covered by a radiation cross-linked modified polyolefin dielectric jacket.

(Optional: For installation on plastic piping, the heater shall be applied using aluminum tape (AT180). To provide a good ground path where none exists and to enhance the heater's ruggedness, the heater shall have an outer braid of tinned-copper and an outer jacket of modified polyolefin (-CR).

5. In order to provide energy conservation and to prevent overheating, the heater shall have a self-regulating factor of at least 90 percent. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heater output going from 40°F pipe temperature operation to 150°F pipe temperature operation.
6. The heater shall operate on line voltages of either 120 or 208-277 volts without the use of transformers.
7. Heater shall operate from a circuit breaker for each tracing circuit.
8. The heat tracing shall maintain minimum "contents" temperature of 40 deg.F at ambient temperature of -20 deg.F when enclosed within a minimum of 1" fiberglass insulation on piping and vessels and pumps, no insulation required on sumps, etc., unless otherwise indicated.
9. Installation:
 - a. Apply the heater linearly on the pipe after piping has been successfully pressure tested. Secure the heater to piping with cable ties or fiberglass tape.
 - b. Apply "electric traced" signs to the outside of the thermal insulation.
10. Tests:

After installation and before and after installing the thermal insulation, subject to testing using a 2500 VDC megger. Minimum insulation resistance should be 20 to 1000 megohms regardless of length.

B. Manufacturers:

1. Manufacturer:	Raychem	Raychem	Raychem
2. Product:	Chemelex	Chemelex	Chemelex
3. Trade Name:	XL-Trace	XL-Trace	XL-Trace
4. Pipe Size:	½"-3"	½" - 3"	4" & Larger
5. Product No.:	5XL-1	5XL-2	8XL-2-CR
6. Voltage:	120V	277V	277V
7. Max Circuit Length:	270 Ft.	470 Ft.	350 Ft.
8. Thermal Rating:	5 Watts/Ft.	5 Watts/Ft.	8 Watts/Ft.
9. Connection:	RAYCLIC-PL	RAYCLIC-PL	RAYCLIC-PL
10. Splice Kit & Tee Kit:	RAYCLIC-T	RAYCLIC-T	RAYCLIC-T
11. End Seal Kit:	RAYCLIC-S	RAYCLIC-S	RAYCLIC-S
12. Thermostat:	RAYCLIC-E	RAYCLIC-E	RAYCLIC-E
13. Glass Cloth Adhesive Tape:	GT-66	GT-66	GT-66

C. Responsibilities:

1. Heat trace including all accessories shall be furnished as part of the Work included in Division 23. Installation of cable on pipe including splices, strapping and bulb placement shall be by Division 23 Contractor.
2. Installation of power wiring including breakers and mounting thermostat enclosure shall be part of the Work included in Division 26.
3. Work under Division 23 includes coordination of material quantity and delivery, tracing installation, and insulation of piping after heat trace has been installed, inspected and tested.

2.8 DIELECTRIC PIPE FITTINGS AND ISOLATORS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Approved Manufacturers: A.Y. McDonald, Capitol, Central Plastics Co, HART Industrial Unions, Jomar, Matco-Norca, Watts, Wilkins, Zurn.
2. Standard: ASSE 1079.
3. Pressure Rating: 150 psig minimum at 180°F.
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Approved Manufacturers: Capitol, Central Plastics Co, Matco-Norca, Watts, Wilkins, Zurn.
2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly, pressure Rating: 150 psig minimum at 180°F. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Isolation Kits:

1. Approved Manufacturers: Advance Products & Systems, Calpico, Central Plastics Co., Pipeline Seal and Insulator.
2. Nonconducting materials for field assembly of companion flanges. Pressure Rating: 150 psig minimum at 180°F. Gasket: Neoprene or phenolic. Bolt sleeves: Phenolic or polyethylene. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Standard: IAPMO PS 66.
2. Electroplated steel nipple complying with ASTM F1545. Pressure rating: 300 psig minimum at 225 °F. End connections: Male threaded or grooved. Lining: Inert and noncorrosive, propylene.

2.9 SOLVENTS FOR PLASTIC PIPING

- A. Primer and Solvent Cements: As recommended by pipe and fitting system manufacturer and complying with ASTM F2618 and ASTM F493. All primers and solvents shall be certified low volatile organic compound (VOC) to meet SCAQMD Rule #1168/316A.

2.10 EQUIPMENT DRAINS AND OVERFLOWS

- A. Steel Pipe: ASTM A53, Schedule 40 galvanized.

1. Fittings: Galvanized cast iron, or ANSI/ASTM B16.3 malleable iron.
2. Joints: Threaded, or grooved mechanical couplings.

- B. Copper Tubing: ASTM B88, Type M, hard drawn.

1. Fittings: ANSI/ASME B16.23 cast brass, or ANSI/ASME B16.29 solder wrought copper.
2. Joints: ASTM B32, solder, Grade 95TA.

- C. Stainless Steel Pipe: ASTM A312, type 316.

1. Fittings: ASTM A351 and ANSI SP-114.
2. Joints: Threaded.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION

- A. General: Unless otherwise specifically indicated on Drawings or in Specifications, install equipment and materials in accordance with recommendations of manufacturer, including performance of tests as manufacturer recommends.

- B. Protection:
 - 1. Close ends of pipe and ductwork during construction and cover equipment to prevent entry of foreign material. Protect insulation against dirt, water, chemical or mechanical damage before, during and after installation. Cover floor drains and protect fixtures and equipment against damage during concrete pours and mechanical work.
- C. Quiet Operation and Vibration:
 - 1. All work shall operate in accordance with Section 230540 - Mechanical Sound and Vibration Control under all conditions of load.
 - 2. Sound or vibration conditions not in accordance with Section 230540 and considered objectionable shall be corrected in a manner approved by the Architect under the Work of Division 23.

3.2 WELDING

- A. Joints between sections of pipe, between pipe and fittings, shall be fusion welded. Use only certified welders. Strength of finished welded joints to be equal to strength of pipe. Width of finished weld to be at least 2-1/2 times the thickness of the part joined. Thickness of weld to be at least 25% greater than the thickness of pipe or fittings. Finished welded joints to present neat and workmanlike appearance.
- B. Make no direct welded connections to valves, strainers, apparatus, and related equipment. Make connections to flanged valves, and flanged equipment with welded pipe connection flanges.
- C. Radii of weld ells to be 1-1/2 times nominal diameter of fittings. Fittings used for all branch connections, whether full-size or reducing, to have interior surfaces smoothly contoured. Wall thickness of welded fittings equal to adjacent piping.

3.3 ELECTRIC WIRING

- A. Furnish equipment requiring electrical connections to operate properly and to deliver full capacity at electrical service available.
- B. All control wiring to be in accordance with manufacturer's recommendations; all wiring shall be color coded to facilitate checking.
- C. Unless otherwise indicated, all mechanical equipment motors, starters, and controls shall be furnished, set in place, and wired in accordance with the Electrical Equipment/Wiring Responsibility Matrix on the drawings. Contractor should note that the intent of this electric wiring matrix is to have the Division 23 Contractor responsible for coordinating all control wiring as outlined, whether or not specifically called for by the mechanical or electrical drawings and specifications. Mechanical Contractor shall comply with the applicable requirements of Division 26 for electrical work of this Division 23 which is not otherwise specified. No extras will be allowed for Contractor's failure to provide for these required items. The Division 23 Contractor shall also refer to the Division 26 specifications and plans for all power and control wiring and shall advise the Architect/Engineer of any discrepancies prior to bidding.

ELECTRICAL EQUIPMENT/WIRING RESPONSIBILITY MATRIX

Item	Furnished By*	Set By*	Power Wiring*	Control Wiring*
Equipment Motors	MC	MC	EC	MC
Motor Starters & Overload Heaters	MC – Except when shown on MCC	EC	EC	MC
Variable Frequency Drives (VFDs)	MC	EC	EC	MC
Fused & Unfused Disconnect Switches, Thermal Overload & Heaters	EC	EC	EC	--
Manual Switches & Speed Control Switches carrying full load currents.	MC	EC	EC	EC
Fire/Smoke and Smoke Dampers	MC	MC	EC – Requires emergency power circuit if air system served is on emergency power.	EC
Control Relays & Transformer (See Note 2)	MC	MC	EC	MC
Thermostats (Line Voltage)	MC	EC	EC	EC
Temperature Control Panels	MC	MC	EC	MC
Building Fire Alarm System Fire & Smoke Detectors, including Relays in Starters for Fan Shutdown.	EC	EC	EC	EC
DDC Interface to Fire Alarm System	MC	MC	EC	MC
Electric Plumbing Fixtures, Sensor Faucets, Sensor Flush Valves, Electric Water Coolers, and required Transformers.	MC	MC	EC	MC
Motor & Solenoid Valves, Damper Motors, PE & EP Switches, Control Valves, Low Voltage Thermostats	MC	MC	MC	MC
Pushbutton Stations & Pilot Lights (manually operated switches not carrying load currents).	MC	MC	N/A	MC
Pushbutton Stations & Pilot Lights carrying fully load current.	MC	EC	EC	N/A
Exhaust fans for kitchen hoods or fume hoods where interlocked with make-up air fans.	MC	MC	EC	EC
Exhaust fans when switched with room lights.	MC	MC	EC	EC

Item	Furnished By*	Set By*	Power Wiring*	Control Wiring*
Boiler Controls including Gas Train	MC	MC	EC	MC
Fire sprinkler system alarms, tamper switches, flow switches and fire alarm systems tie-ins to provide a complete fire protection system.	FPC	FPC	FPC	FPC
Water Softener Timeclocks, Timers, Lock-out Devices, Wheatstone Bridges and Meters	MC	MC	EC	MC
Temporary Heating Connections	MC	MC	EC	MC
Freeze Protection Heat Cable	MC	MC	EC	MC
Heat Maintenance Cable	MC	MC	EC	--
HVAC Water Treatment Interlocks and Glycol Pumps	MC	MC	EC	MC

- * MC = Mechanical Contractor under Division 23 of the work.
- * FM = Mechanical Contractor under Section 212200 - FM-200 Fire Suppression System.
- * FPC = Fire Protection Contractor.
- * EC = Electrical Contractor under Division 26 of the work.
- * MGES = Medical Gas Equipment Supplier (Section 226313).

- D. All temperature control conduit and wiring shall be furnished and installed under Section 230900. All motorized damper and motorized valve wiring shall be furnished and installed under Section 230900.

3.4 SLEEVES, PLATES AND CLOSURES

- A. Division 23 Contractor shall provide and locate pipe sleeves, and inserts required before new floors and walls are built or shall be responsible for the cost of cutting and patching required where sleeves and inserts were not installed or where incorrectly located.
- B. Provide sleeves for mechanical piping passing through concrete floor slabs and through concrete, masonry, tile, and gypsum wall construction. Provide metal collars to close and protect openings.
- C. Where sleeves are placed in exterior walls below grade, pack spaces between the pipe or conduit and the sleeves with Hornflex Thiokol L-32 Sealant or Link Seal and make water-tight. Provide metal rodent collars securely fastened to structure. Link seal shall not be used on fire lines.
- D. Where pipe motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Where sleeves pass insulated pipes, the sleeves shall be large enough to pass the pipe only and the insulation shall be made to butt against the construction, except for pipes requiring insulation having a vapor barrier, in which case, the sleeves shall be large enough to pass the pipe and insulation. Check floor and wall construction finishes to determine proper length of sleeves for various locations, make actual lengths to suit the following:
 - 1. Terminate sleeves flush with floors, walls, partitions, and ceilings.
 - 2. Seal annular space around pipes watertight at floor penetrations.

3. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor.
 4. In all areas where pipes are exposed, extend sleeves 1/4" above finished floor, except in rooms having floor drains, where sleeves shall be extended 2" above floor and in Kitchens and Mechanical Equipment Rooms, where sleeves shall be extended 4" above floor.
- E. Sleeves shall be constructed of 24 gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated on the drawings. "Crete Sleeve" (plastic type) sleeves are acceptable for concrete construction as manufactured by Sperzel Division, Shamrock Industries or Willoughby Industries.
- F. Fasten sleeves securely in floors and walls so that they will not become displaced when concrete is placed or when other construction is built around them.
- G. Provide tight fitting floor and ceiling plates on pipes passing thru walls, ceilings, and floors. Nickel or chrome plated in finished areas, galvanized cast iron in unfinished areas. Provide wall and ceiling flanges for ducts in finished areas.
- H. Provide all cutting, patching of holes, openings, notches. Obtain written approval for notching, boring, chipping, burning, drilling, welding to structural members in accordance with the General Conditions of the Contract and paragraph 3.7 of this Section.
- I. Where pipe sleeves penetrate fire rated walls and floors, this contractor shall use fire safing to seal openings.

3.5 FOUNDATIONS, PADS AND CURBS

- A. Provide dowels, anchor bolts, groutings, concrete foundations and pads for pumps, plumbing, heating and ventilating or air conditioning equipment in accordance with Concrete Specifications.
- B. Dimensions and exact locations for foundations and concrete curbs for mechanical equipment to be field verified and located accurately by Division 23 Contractor.
- C. When water heaters and similar equipment are installed in a suspended application, an engineered and manufactured platform shall be used. Weight loading capability shall include a minimum safety factor of 2.

3.6 EXCAVATING AND BACKFILLING

- A. Excavate for all mechanical equipment such as fuel tanks, ductwork, sump pumps, manholes and trenches for underground pipelines to required depths. Compact bottoms of excavations. Slope to obtain required grade. Remove rocks, trash and debris before installation of equipment and backfilling. Backfill by hand tamping earth under the haunch of the pipe to specified compaction. Backfill and compact in thin layers until top of pipe is covered. Complete backfill by methods required or directed for soil characteristics to comply with the Architectural section of these specifications.

- B. Excavations near footings shall be such that, when nearing building footings, or bearing foundation walls, the excavation bottom shall not be nearer the footing than a normal 45 degree bearing line from edge of footing bottom to bottom of excavation. When it is necessary to perpendicularly cross under a continuous foundation wall, care shall be taken to insure that crossing is clear of the structural foundation and of minimal width.
- C. Do not place backfill over pipe lines until lines are properly tested.
- D. When trenching through specially tested areas, such as paving, asphalt, etc., Contractor shall be responsible for restoring the surface to its original condition, and in a manner approved by the Architect. Repair trenches where settlement occurs, and restore the surface for the period of one year after final acceptance of the project. All cutting of paving, asphalt, etc. shall be by saw cutting.

3.7 CUTTING AND PATCHING

- A. Openings in New Construction:
 - 1. Provisions for New Openings: The Division 23 Contractor shall verify all openings required in the new construction in connection with the work under Division 23 with the Architectural and Structural Drawings and shall then meet with and verify same with the General Contractor/Construction Manager who will assign the work to the appropriate contractor to provide all openings in the new construction of the correct size and location in walls, floors or through roofs required for the installation of the mechanical work.
- B. Cutting in New Construction:
 - 1. Failure on the part of the Division 23 Contractor to make the above arrangements for required openings shall cause the cost of cutting and patching for the necessary openings for the installation of his work to be borne by him, either by being assigned to the General Contractor/Construction Manager or in the form of performing the required cutting himself. In either case, all patching shall be done by the appropriate finishing contractor as determined by the General Contractor/Construction Manager. No cutting or drilling of holes shall be done without approval of the Architect/Engineer.
- C. Patching in New Construction:
 - 1. The appropriate finishing contractor as determined by the General Contractor/Construction Manager shall patch all openings in the new structure. All openings made in fire rated walls, floors, or ceilings, shall be patched and made tight to conform to the fire rating for the enclosure. All materials used in patching shall match the materials specified in the Architectural Specifications and all patched areas shall be restored to the specified finish surface to the satisfaction of the Architect.
 - 2. The Division 23 Contractor shall pay the appropriate Finishing Contractor as determined by the General Contractor/Construction Manager for all patching resulting from cutting to accommodate mechanical work.

D. Cutting in Existing Building:

1. The Construction Manager/General Contractor shall make arrangements for required openings in the existing building to facilitate the passage of ductwork, piping, etc. thru existing floors, walls, and beams. Division 23 Contractor to coordinate all requirements.

E. Patching in Existing Building:

1. The General Contractor shall patch all existing walls and floors to match existing.

3.8 PIPE HANGERS/SUPPORTS

- A. Use inserts, anchors, expansion bolts or other approved and acceptable means of attachment to concrete construction. Set inserts in advance of concrete installation, provide required reinforcement rod for all inserts carrying loading equivalent of one 4" pipe or more. All inserts shall be flush with face of slab or wall containing insert.
- B. Provide flat square washers for rods thru metal decking with nut above washer, when acceptable and approved.
- C. Cinch hangers to carry appropriate share of loading and slope piping without sags or "pocketing" as appropriate and required.
- D. Rod offsets, or angle installation, plumber tape or wire will not be accepted. Hanger rods shall be true and plumb.
- E. Piping shall not be hung from other piping or equipment items. Provide attachments to building structure only. Use trapeze, wall brackets, knee brackets, etc., where hanger rods cannot be attached within spacing plumb to structures.
- F. Provide sway and earthquake bracing where required in accordance with Section 230548 - Mechanical Seismic Control.

3.9 INSTALLATION OF VALVES

- A. General:
 1. Provide valves as shown on Contract Documents and as required for pressure relief, balancing and/or control of flow.
 2. Provide isolation valves for maintenance and service on each piece of equipment regardless of whether or not shown on Contract Drawings.
 3. Provide isolation valves for all branch line take-offs that serve more than two items of fixtures or equipment.
 4. Provide balancing valves for each branch of domestic hot water circulating system, all heating/cooling water returns or supplies to equipment, and as shown on Contract Documents.
 5. Provide access means for each valve or group of valves either by access panels or utilization of inherent access provided by building methods i.e., lift out ceiling construction or exposed valve installations in non critical areas such as janitor's closets, storage rooms, etc.

6. Install all valves with valve bonnets or operating stems in vertical (upright) position when possible, valves may be installed with bonnets or stems not less than 35 degrees downward from vertical plane except valves on vertical piping may be 90 degrees from vertical plane. Swing type check valves shall be installed on horizontal piping no more than 45 degrees upward slope from horizontal plane, using lift checks on vertical piping. Lift check valves shall not be used on sewage or sump pump discharge piping.
 7. Inspect and tighten all bonnet nuts, bolts, packing glands, lubricate all valves requiring lubrication, secure all hand wheels and identification plates, be responsible for all valves having manufacturers name, trade name, working pressure and size stamped or cast into the body of the valve. Perform all maintenance, repacking and inspection prior to installation of valve.
- B. Proper Installation of Valves:
1. Provide valves in accordance with the following schedule unless specified otherwise in Contract Documents.
 - a. Dead-end shut off: Gate, ball, butterfly, plug, stop and drain.
 - b. Throttling: Ball, plug, globe, diaphragm, needle, butterfly (when using butterfly valves for throttling, additional valves must be provided for service shutoff.)
 - c. Backflow prevention: Check.
 - d. Water hammer prevention: Silent or pilot operated non slam check.
 - e. Gas piping: Lubricated plug (or ground joint cock up to 1" only), or UL-Listed ball valve.
- C. Removal and Repair Provisions:
1. Provide all valves which are not accessible for repair without removal from piping with union connection immediately adjacent to valve outlet.

3.10 PAINTING

- A. Surfaces of exposed equipment and materials to be thoroughly cleaned and left ready for painting in accordance with Architectural Painting Specifications.
- B. Duct interiors visible through registers, grilles and diffusers shall be painted flat black.
- C. Exposed gas piping to be cleaned, primed and two coats of paint (grey).
- D. All other painting of mechanical equipment and piping, unless otherwise noted, shall be performed under other divisions of the work with the exception of identification of piping and equipment which will be the responsibility of the Division 23 Contractor.

3.11 IDENTIFICATION OF PIPING AND EQUIPMENT

- A. General: Provide pipe identification, valve tags, stencils, or engraved nameplates to clearly identify the mechanical equipment, piping and controls of the various mechanical systems and direction of flow in piping.

B. Methods for identification shall be as follows:

1. Metal Tags: Stamp tags with letter prefixes to indicate service, followed by a number for location in system.
2. Engraved Nameplates: Attach nameplates with brass screws. Pressure-sensitive embossed labels are not acceptable. Nameplates shall bear the same identifying legend used on the Contract Documents.
3. Painted Stencils: Stenciled markings shall be neatly performed with no overspray, drips, or other imperfections. Pipes and equipment to be stenciled shall first be wiped clean of dirt, dust, rust, grease and moisture. Pipes and smooth, hard surface in the area the stencil is to be applied. Paint application shall comply with Architectural Painting Specifications.
Size of Legend and Letters for Stencils:

Insulation or Pipe Diameter	Length of Color Field	Size of Letters
3/4" to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
over 10"	32"	3-1/2"
Ductwork and Equipment	NA	2-1/2"

4. Piping Legend and Color (Contractor shall obtain written approval of colors from Owner's representative prior to starting work.)

Legend	Background Color	Direction Arrow	Pressure
Condensate	Yellow	Arrow	PSI
Feed Water	Yellow		
Chilled Water	Light Green	Arrow	
Tower Water	Light Green	Arrow	
Compressed Air	Light Blue		PSI
Medical Air	Black		PSI
Blow Down	Yellow		
Domestic Cold Water	Light Green		
Domestic Hot Water	Yellow		
Sprinkler-Fire	Red		
Natural Gas	Orange		
Heating Water	Yellow	Arrow	
Refrigerant Liquid	Yellow	Arrow	
Refrigerant Suction	Yellow	Arrow	
Refrigerant Hot Gas	Yellow	Arrow	

5. Pressure Sensitive Markers: Apply pressure sensitive markers in accordance with manufacturer's recommendations with complete wrap around may be used at Contractor's option. Marker adhesion will be tested for permanence. Any markers showing dog ears, bubbles, or other failings shall be replaced.
6. Semi-Rigid Plastic Identification Markers: Seton Setmark premolded (not pressure sensitive) identification markers may be used at Contractor's option on service piping which is accessible for maintenance operations (but not on piping in finished spaces). This type marker shall not be installed on bare pipe when surface temperature exceeds 180 deg.F unless a 1" thick insulation band is first provided under marker for protection from the hot pipe.

- C. Identification of Piping: Identify all piping accessible for maintenance tunnels, above ceilings, and access spaces as well as exposed to view utilizing either pressure sensitive markers, semi-rigid plastic markers, or stenciled markings according to the following procedures:

1. Use an arrow marker for each pipe-content legend. The arrow shall always point away from the pipe legend and in the direction of flow: color and height of arrow to be same as content legend lettering.
2. If flow can be in both directions, use a double-headed arrow indication.
3. Apply pipe legend and arrow indication at every point of pipe entry or exit where line goes thru wall or ceiling cut.

4. Apply pipe legend and arrow indication within 3" of each valve to show proper identification of pipe contents and direction of flow.
 5. The legend shall be applied to the pipe so that lettering is in the most legible position. For overhead piping, apply legend on the lower half of the pipe where view is unobstructed, so that legend can be read at a glance from floor level.
 6. For pipes under 3/4" O.D., fasten brass tags securely at specified legend locations.
 7. Legend on steam piping, condensate return, compressed air, medical air, gas, and vacuum systems shall include working pressure or vacuum.
 8. Insulated piping equipped with electric heat trace shall additionally be labeled "Electric Traced" with label of same size and color as the pipe legend.
- D. Valves: All valves, including but not limited to domestic hot and cold water, hot water recirculation, heating water, chilled water, condenser water, steam, steam condensate return, fire protection, gas, medical gas, vacuum and special service valves located inside the building, shall be tagged and identified as to type of service, location number, and normal valve position (normally open or normally closed).
- E. Controls: All magnetic starters and relays, shall have nameplates or be stenciled to identify connecting or controlled equipment. All manual operating switches, fused disconnect switches and thermal over-load switches which have not been specified as furnished with indexed faceplates shall also have nameplates or be stenciled as to "connected" or "controlled" equipment. All automatic controls, control panels, zone valves, pressure electric, electric pressure switches, relays, and starters shall be clearly identified.
- F. Pumps: All pumps shall be identified as to service and zones served. Base mounted pumps shall be stenciled or have system served nameplates. Brass tags secured by brass chains may be used on small in-line pumps.
- G. Storage Tanks, Water Treatment Equipment and Heaters: All tanks and heaters shall be stenciled as to service. The connecting pipes to each shall be identified and the service temperature entering and leaving the tank or heater shall be indicated.
- H. Fans: All supply and exhaust fans and air handling units and connecting ductwork supplying one or more areas from an equipment room or isolated crawl or furred space shall have nameplate or be stenciled as to plan code number, service and areas of zones served.
- I. Air Conditioning Equipment: Air conditioning equipment such as chillers, pumps, condensers, or roof-top equipment shall be identified by stencils, or system nameplates.
- J. Access Doors: Provide engraved nameplates or painted stencils to identify concealed valves, controls, dampers or other similar concealed mechanical equipment. Obtain Architect approval before installation on all access doors in finished areas.
- K. Lift Out Ceilings: Provide engraved nameplates or black lettering on transparent adhesive labels on ceiling tee stem to identify concealed valves, controls dampers or similar concealed mechanical equipment which is directly above nameplate in ceiling space. Obtain Architect approval before installation.
- L. Expansion tanks shall be labeled to indicate system served and precharge pressure.

3.12 DRIP PANS

- A. Provide drip pans under all fluid conducting piping which runs over servers, telecom equipment, electric switchgear, busway, or electric motor starters, and under all point-of-use water heaters.
- B. Pans: 18 gauge galvanized iron. Pans shall be two inch deep, with rolled top edges, and shall extend six inches each side of the pipe or group of pipes and six inches beyond the equipment below. Keep pans as close to the underside of the pipes as practicable. All seams shall be soldered, and pans shall be crossbraced as required to prevent sagging and warping.
- C. Pitch each pan to a drain connection, and pipe a 1-1/2 inch or larger copper tube drain to discharge over nearest available open drain.
- D. Provide a drip pan under all coils that may have condensate during operation like heat recovery coils, etc. Pipe drain to nearest drain.

3.13 FIRE SAFING

- A. Mechanical Contractor shall provide fire safing for his work as follows: Where fire rated separations are penetrated by pipes, conduit or ductwork, the annular space around the pipe, conduit or ductwork shall be filled with a U.L. Rated fire safing material. Refer to Division 7 for materials and application specifications.

3.14 HEAT MAINTENANCE CABLE AND FREEZE PROTECTION CABLE

- A. Comply with National Electric Code Section 427 for installation.
- B. Protect heater strips from damage before, during and after installation.
- C. Provide waterproof insulation for all heat traced and heat maintained piping one inch thick minimum in accordance with Section 230700.
- D. When installing do not twist buss wires together.
- E. Test each circuit prior to and immediately after installation of thermal insulation using a megger under 500 volts D.C. Minimum insulation resistance reading shall be ten (10) megohms regardless of length, if less than ten (10) megohms investigate cause and replace damaged sections - do not repair!
- F. Install heat cable on lower quadrant of pipe 45 degrees up from vertical, provide ties or fiberglass tape 12" on center max.
- G. Install all accessories and kits per manufacturers' recommendations and standards. Careful attention to manufacturers' installation instructions as pertains to valves and equipment will be strictly adhered to and enforced.

3.15 DIELECTRIC PIPE FITTINGS AND ISOLATORS

- A. Provide dielectric pipe fittings and isolators at all connections between dissimilar metals in the domestic water, HVAC pipe, and fire protection systems to control corrosion potential caused by galvanic or electrolytic action.

- B. Typical locations for dielectric isolation are; water heaters, storage and pressure tanks, water conditioning equipment, pumps, changes in service piping materials, make-up connections to boilers and chilled water systems, valves, deaerators, flexible connectors and the like where materials of different electrode potential are joined.
- C. Hangers for piping shall be isolated per Section 230529 when hanger and piping materials are dissimilar and subject to production of electrolysis or galvanic action.
- D. Storage tanks shall be isolated from piping and tank stands by use of anti-electrolytic and galvanic isolators.

3.16 DRAIN LINES

- A. Provide condensate drain lines from each cooling coil and evaporative media sump drain pan to nearest drain or to termination indicated.
- B. Do not route condensate lines above electrical panels, switch gear, transformers, motor starters, elevator equipment, servers, or telecom equipment. Should there be a conflict with the plans and this paragraph, notify the Engineer immediately for corrective instruction prior to starting work.

3.17 HEATING SYSTEM USED FOR TEMPORARY HEAT DURING CONSTRUCTION

- A. Permanent heating system shall not be used until building is totally and permanently enclosed (no temporary barriers for weather protection), and source of heat supply is permanently installed.
- B. Once the heating system has been placed into operation, it shall not be shut down except for moderate weather, and all heated areas shall be maintained at a minimum temperature of 50 deg. F 24 hours a day.
- C. When any air-handling equipment is used for temporary heat, the filters (MERV 13) shall be installed and maintained. Before building acceptance by Owner, these units shall be thoroughly cleaned and new filters shall be installed. This is over and above the extra set of filters to be provided the Owner as called for in the specifications. Coils shall be cleaned if necessary, as determined by the Engineer. If project is LEED provide additional MERV 8 filter overall return grilles to prevent debris from entering. Tape around perimeter edge to seal to grille.
- D. Any and all systems being used for temporary heat shall become the Contractor's responsibility to maintain, and be put into first class working order before acceptance by the Owner.
- E. Any manufacturer's guarantees that start with the use of equipment for temporary heat shall be extended by the contracting firm holding the prime contract for construction, so that the Owner will have his one-year guarantee from date of acceptance.

3.18 EXISTING PIPES AND MECHANICAL EQUIPMENT TO BE REMOVED

- A. Where existing mechanical equipment, fixtures and/or piping is to be removed and/or relocated, all piping shall be disconnected and capped. All existing piping and hangers not to remain in use shall be removed completely to an existing main that is to remain in use, and capped at the main. General Contractor shall do all cutting, patching, and restoring that may be required for the removal of this piping and equipment. Where it is not possible to remove branch piping not remaining in use, due to its being concealed in the structure, the Division 23 Contractor shall cap the piping concealed at both ends in these areas as approved by the Architect.
- B. All mechanical equipment, fixtures, and piping to be removed and not re-used shall remain the property of the Division 23 Contractor for credit to the contract price except as noted otherwise.

END OF SECTION 230529

**SECTION 230540
MECHANICAL SOUND AND VIBRATION CONTROL**

PART 1 GENERAL

1.1 RELATED WORK

- A. Requirements: Provide Mechanical Sound and Vibration Control in accordance with the Contract Documents.
- B. Related work specified in other Sections:
 - Section 230500 - Basic Mechanical Requirements
 - Section 230529 - Basic Mechanical Materials and Methods
 - Section 232113 - HVAC Piping & Specialties
 - Section 233300 - Ductwork and Accessories - Flexible Ductwork Connections

1.2 SYSTEM DESCRIPTION

- A. The work includes, but is not limited to the following:
 - 1. Support isolation for motor/driven mechanical equipment.
 - 2. Rails or beams for distribution of equipment loading to isolation units.
 - 3. Fabricated bases for distribution of equipment loading to isolation units.
 - 4. Inertia base frames in conjunction with equipment isolation.
 - 5. Isolation of pipes and ductwork.
 - 6. Sound attenuating units.
 - 7. Sound-linings.
 - 8. Sound proofing of construction.
 - 9. External sound proofing.

1.3 QUALITY ASSURANCE

- A. The Division 23 Contractor shall be responsible for assuring that all the following sound pressure level criteria are met. Sound pressure level tests shall be carried out by the Section 230593 Contractor in compliance with the Section 230593 specifications.
- B. Acoustical Criteria:
 - 1. Noise levels due to equipment and ductwork to permit attaining sound pressure levels in all 8 octave bands in occupied spaces conforming to RC curves:
 - All occupied spaces ----- RC-35
 - except
 - Occupied spaces within 15 foot radius from mechanical rooms, main supply and return duct shafts ----- RC-40
 - Lobbies, Toilets, Commons Area ----- RC-40

 - Mechanical Rooms ----- RC-60-80
- C. Mechanical Acoustical Performance:

1. Air Distribution system equipment terminal device noise:
 - a. Maximum permissible discharge sound-power levels in octave bands of airborne transmission through the terminal units or related pressure reducing devices, when operated in installed condition per Drawings and Specifications shall be as per Table 1, following:

TABLE 1 - Maximum PWL (dB re 10E-12 Watt)				
Octave Band	RC-30	RC-35	RC-40	RC-45
1	54	59	64	69
2	68	73	78	83
3	61	66	71	76
4	59	64	69	74
5	51	56	61	66
6	48	53	58	63
7	39	44	49	54

2. Pressure reducing variable air volume boxes radiated noise:
 - a. Maximum permissible radiated sound-power levels in octave bands when operated in an installed condition over occupied spaces, shall be as per Table 2 following:

TABLE 2 - Maximum PWL (dB re 10E-12 Watt)				
Octave Band	RC-30	RC-35	RC-40	RC-45
1	54	59	64	69
2	62	67	72	77
3	58	63	68	73
4	55	60	65	70
5	53	58	63	68
6	50	55	60	65
7	46	51	56	61

3. Motor Acoustical Performance:
 - a. Motor drives for pumps when installed per Drawings and Specifications shall operate with noise levels not exceeding 90dba.
 - b. Noise levels shall be determined in accordance with IEEE Standard #85 Test "Procedure for Air-Borne Noise Measurements on Rotating Electric Equipment.

4. Refrigeration Machine Cooler, Condenser, Compressor and Compressor Piping Acoustical Performance:
 - a. The maximum permissible noise levels under design operating conditions, when measured in accordance with the methods and qualifications specified herein shall not exceed 90 dbA.

1.4 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings and Product Data for the following items in accordance with the General Conditions of the Contract.
 1. Each type of isolator including spring diameters, deflections, compressed spring height and solid spring height.
 2. Sound Attenuators.
 3. Sound Lining.
 4. Inertia Bases.
- B. Test Reports: Submit certified test reports showing compliance in accordance with General Conditions of the Contract of the following items:
 1. Pressure drop and insertion loss ratings for sound attenuators.
 2. Certification that sound lining meets erosion test method described in UL Publication No. 181.

PART 2 PRODUCTS

2.1 PIPING AND EQUIPMENT ISOLATION

- A. Manufacturer: Amber/Booth Co., Kinetics, Korfund, Mason Industries, Inc., Vibration Mountings and Control Co., Vibro-Acoustics.
- B. Neoprene Mounting Pads (Specification Schedule Type 1)
 1. Kinetics Noise Control Type NPD.
 2. Minimum static deflection 0.04" for 0.22" thick pad.
 3. Cross, double ribbed elastomer in-shear pads, capable of 60 or 120 PSI loading, depending on load density of equipment being isolated.
 4. Material thickness as required to provide minimum deflections listed in table at end of the specification section.
- C. Double Deflection Neoprene Mountings (Specification Schedule Type 2)
 1. Mason Industries Type ND Mounting, Type DNR Rails.
 2. Minimum static deflection 0.35 inch.
 3. Bolt holes where required.
 4. Steel rails above mountings to compensate for overhang where required.
- D. Spring Isolator Mountings (Specification Schedule Type 3)
 1. Mason Industries Type SLF.

2. Free-standing, laterally stable without housing, complete with 1/4 inch neoprene acoustical friction pads between base plate and support and with leveling bolts that must be rigidly bolted to equipment.
 3. Spring diameters no less than 0.8 of the compressed height of the spring at rated load.
 4. Springs with minimum additional travel to solid equal to 50 percent rated deflection.
- E. Restrained Spring Isolator Mountings (Specification Schedule Type 4)
1. Mason Industries Type SLR.
 2. Spring isolator mounting equal to Type SLF but with housing that includes vertical resilient limit stops to prevent spring extension when weight is removed from equipment.
 3. Provide hot dipped galvanized mountings exposed to weather.
- F. Vibration Hangers (Specification Schedule Type 6)
1. Mason Industries Type DNH.
 2. Spring and double deflection neoprene element in series.
 3. Neoprene element minimum deflection 0.35 inch.
 4. Spring diameters no less than 0.8 of compressed height of spring at rated load.
 5. Springs with minimum additional travel to solid equal to 50 percent rated deflection.
- G. Integral Structural Steel Base (Specification Schedule Type B)
1. Mason Industries Type WF.
 2. Rectangular for equipment other than "T" or "L" shaped pump bases.
 3. Pump bases for split case pumps to include supports for suction and discharge base ells.
 4. Beams for perimeter members minimum depth equal to one tenth of the longest dimension of the base. Depth need not exceed 14 inches if deflection and misalignment is kept within acceptable limits by manufacturer.
 5. Provide height saving brackets to provide a clearance of one inch.
- H. Steel Rail Base (Specification Schedule Type B)
1. Mason Industries Type ICS.
 2. Steel members welded to height saving brackets to cradle machines having legs or bases that do not require a complete supplementary base.
 3. Provide members sufficiently rigid to prevent strains in the equipment.
- I. Concrete Inertia Bases (Specification Schedule C)
1. Mason Industries Type K.
 2. Rectangular structural beam or channel concrete forms for floating foundations.
 3. Provide bases for split case pumps large enough for suction and discharge base ells supports.
 4. In general, unless shown otherwise on the Drawings, provide bases with a minimum depth of one twelfth of the longest dimension of the base, but not less than 6 inches.

5. Forms to include minimum concrete reinforcement consisting of 1/2 inch bars or angles welded in place on 6 inch centers running both ways in a layer 1-1/2 inches above the bottom, or additional steel as is required by the structural conditions.
6. Forms furnished with drilled steel members with sleeves welded below the holes to receive equipment anchor bolts.
7. Provide height saving brackets to maintain a 1 inch clearance below base.

J. Vertical Inline Pump Floor Stands

1. Vibro-Acoustics SIPS.
2. Enamel Powder Coated Steel
3. Bolt Holes located to match ANSI flange dimensions.
4. Size to accommodate seismic forces of pump and motor combination being provided.

K. Flexible Butyl Hose Pipe Connectors (Up to 2")

1. Mason Industries Type RMM.
2. Flexible Butyl 150 lb. hose with brass screw type ends attached by expansion or swedging methods. Clamps are unacceptable.
3. Duty up to: 100 psi and 220 deg. F.
4. Hoses up to 1-1/4 inches shall be 12 inches in length and 1-1/2 inches to 2 inches shall be 18 inches in length.

L. Flexible Neoprene Sphere Pipe Connectors (2" to 12")

1. Mason Industries Type MFNC and Type MFTNC.
2. Neoprene single-sphere type with 150 lb. ASA steel floating flanges.
3. Duty up to: 150 psi and 230 deg. F.
4. Movement limits: minimal 3/8 inch axial compression, 1/4 inch axial elongation, 3/8 inch lateral movement and 15 deg. angular movement.

M. Braided Flexible Connectors (Drawing Code "FC")

1. Manufacturer: Thermo Tech, Inc., Metraflex, Flex-Hose Co., Flexicraft Industries, Flex-Precision Ltd., Twin City Hose.
2. Flexible connectors manufactured of 300 series stainless steel convoluted metal bellows and braid, 150 psig ASA drilled flanges. Maximum permanent offset from centerline = 3/4". Maximum intermittent offset from centerline = 3/8".
3. Pressure test to be certified for 300 psi at 250 deg. F.
4. Schedule:

Make:	Metraflex								
Model:	SLP								
Size:	1-1/2"	2"	2-1/2"	3"	4"	6"	8"	10"	12"
Connector Length:	6"	6"	10-1/4"	10-5/8"	11-3/4"	14-1/8"	15-3/8"	12-3/4"	18-3/8"
Max Pressure:	300 psig								
Max Temperature:	250 deg. F								

- N. Acoustical Pipe Riser Anchors:
 - 1. Mason Industries Type ADA.
 - 2. All directional acoustical pipe anchor.
 - 3. Minimum 1/2 inch thickness of heavy duty neoprene isolation material.
 - 4. Vertical restraints in either direction.

2.2 SOUND ATTENUATORS

- A. Acceptable Manufacturers: SEMCO Manufacturing, Industrial Acoustics Company, Acoustifoil Noise Control Products, Koppers, Rink, Commercial Acoustics, Dynasonics, Vibro-Acoustics, Price.
- B. Factory prefabricated.
- C. Shell:
 - 1. Galvanized Steel: 22 ga. minimum.
 - 2. Leakproof at pressure differential of 8 in. w.g.
- D. Media:
 - 1. Flamespread: Maximum 25.
 - 2. Fuel contributed and smoke developed: Maximum 50.
 - 3. Maximum 4.5 lbs. per cubic foot density glass or mineral fiber packed under 5 percent compression.
 - 4. Filler to be inert, vermin and moisture proof.
 - 5. Non-erosive and non-pregnable.
- E. Internal Construction:
 - 1. Galvanized perforated steel baffles: Minimum 24 gauge.
 - 2. Cleanable construction.
- F. Net Insertion Ratings:
 - 1. Determined by duct-to-reverberant room test method at design airflow shall be as per Table 3 following:

TABLE 3			
Band No.	Band Center Freq. (HZ)	Sound Trap Dynamic Insertion Loss(db)	
		5 Feet	3 Feet
1	63	6	4
2	125	10	7
3	250	18	12
4	500	30	19
5	1000	42	23
6	2000	34	23

- G. Maximum self-generated noise at 2000 ft. per minute face velocity shall be as per Table 4 following:

TABLE 4 - Sound Trap Self-Noise Level		
Band No.	Band Center Freq. (HZ)	Sound Trap Self-Noise (db re 10E-12W) 5 ft. & 3 ft.
1	63	63
2	125	54
3	250	52
4	500	50
5	1000	47
6	2000	48

2.3 SOUND LININGS

- A. Acceptable Manufacturer: Johns Manville Permacote, Linacoustic and Spiracoustic.
- B. Other acceptable manufacturers offering equivalent products: Knauf, CertainTeed ToughGuard R.
- C. Product: Fibrous glass, acrylic surface coating, stenciled NFPA, conforming to ASTM C1071 (air velocity), ASTM G21 (fungi resistance) and ASTM G22 (bacteria resistance). Product shall not allow growth of mold or bacteria. This anti-microbial compound shall be tested for efficacy by a nationally recognized testing laboratory (NRTL) and be registered by the EPA for use in HVAC systems.
- D. Minimum thickness: As indicated in Part 3 of this specification.
- E. Sound Absorption Coefficient for 1.5" thickness per the following:
- | | | | | | | | | |
|-----------------|---|------|------|------|------|------|------|------|
| Frequency (cps) | = | 125 | 250 | 500 | 1000 | 2000 | 4000 | NRC |
| Coefficient | = | 0.10 | 0.47 | 0.85 | 1.01 | 1.02 | 0.99 | 0.85 |
- F. Flamespread Index: Maximum 25.
Smoke Developed Index: Maximum 50.
Tested in accordance with ASTM E84 and UL723. Provide UL labels on product packaging.
- G. Suitable for duct velocity of 5000 fpm. Lining shall meet erosion test method described in UL Publication No. 181.
- H. Dynamic loss coefficient: Maximum 1.2.
- I. Thermal conductivity 0.24 Btu inch/h Ft² °F @ 75°F mean temperature.
- J. Provide additional facing for protection of acoustical liner at plenum fan discharge plenum in field-built, single wall fan plenums. Liner shall be 26 gauge steel with perforated 28% minimum open area.

2.4 ADHESIVE AND SEALER

- A. Acceptable Products: Adhesive, Benjamin Foster "81-99", or accepted equal, Sealer, Benjamin Foster "82-07" or accepted equal.
- B. In conformance with NFPA 90A.
- C. Flamespread: Maximum 25.
- D. Fuel contributed and smoke developed: Maximum 50.

2.5 NON-HARDENING CAULKING

- A. Acceptable Products: Tremco "Polybutene", Schuller or accepted equal.
- B. Guaranteed to be permanently elastic.

2.6 VIBRATION DAMPING COMPOUND

- A. Acceptable Manufacturers: Soundcoat GP-1 Vibration Damping Compound, Korfund Dynamics Corporation Vibro-damp 80A, Kinetics, Vibro-Acoustics.
- B. Non-burning.
- C. Compound shall effectively damp vibrations for a broad frequency range between 10 Hz to 20 kHz.
- D. Decay rate Geiger plate 45 dB/sec. at 72 deg. F.

2.7 EXTERNAL SOUND BARRIER INSULATION

- A. Acceptable Manufacturers: Kinetics Noise Control, Vibro-Acoustics.
- B. Model: KNM 100 ALQ-1.
- C. Sound barrier shall be a barrier/decoupling layer composite consisting of 1.0 lb. per ft² mass barrier bonded to 1" fiberglass batting, non-woven porous scrim-coated glass cloth, quilted together to encapsulate the glass fibers. Provide with barrier tape for sealing joints.

D. Sound Transmission Loss:

1. Transmission loss when attached to outside of piping shall be as per the following table:

Band No.	Band Center Freq. (Hz)	Transmission Loss (dB)
1	125	13
2	250	16
3	500	24
4	1000	33
5	2000	43
6	4000	49
-	STC	28

E. Flamespread: Maximum 25.

F. Fuel contributed and smoke developed: Maximum 50.

2.8 EXTERNAL SOUND BARRIER INSULATION (PIPING)

A. Acceptable Manufacturers: Kinetics Noise Control, Vibro-Acoustics.

B. Model: KNM 100 ALQ-1.

C. Sound barrier shall be a barrier/decoupling layer composite consisting of 1.0 lb. per ft² mass barrier bonded to 1" fiberglass batting, non-woven porous scrim-coated glass cloth, quilted together to encapsulate the glass fibers. Provide with barrier tape for sealing joints.

D. Sound Transmission Loss:

1. Transmission loss when attached to outside of piping shall be as per the following table:

Band No.	Band Center Freq. (Hz)	Transmission Loss (dB)
1	125	13
2	250	16
3	500	24
4	1000	33
5	2000	43
6	4000	49
-	STC	28

E. Flamespread: Maximum 25.

- F. Fuel contributed and smoke developed: Maximum 50.

2.9 EXTERNAL SOUND BARRIER INSULATION (SHEET METAL)

- A. Acceptable Manufacturers: Kinetics Noise Control, Vibro-Acoustics.
- B. Model: KNM 100 ALQ-1.
- C. Sound barrier shall be a barrier/decoupling layer composite consisting of 1.0 lb. per ft² mass barrier bonded to 1" fiberglass batting, non-woven porous scrim-coated glass cloth, quilted together to encapsulate the glass fibers. Provide with barrier tape for sealing joints.
- D. Sound Transmission Loss:
 - 1. Transmission loss when attached to outside of piping shall be as per the following table:

Band No.	Band Center Freq. (Hz)	Transmission Loss (dB)
1	125	13
2	250	16
3	500	24
4	1000	33
5	2000	43
6	4000	49
-	STC	28

- E. Flamespread: Maximum 25.
- F. Fuel contributed and smoke developed: Maximum 50.

PART 3 EXECUTION

3.1 GENERAL - PIPING AND EQUIPMENT ISOLATION

- A. Unless otherwise noted on the Equipment Mounting Schedule, provide mechanical equipment mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators to be selected in accordance with the weight distribution so as to produce reasonable uniform deflection. Deflections to be as noted on the Equipment Mounting Schedule included at the end of this section.
- B. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following the isolation work, to avoid any contact which would reduce the vibration isolation.

- C. The installation or use of vibration isolators must not cause any change of position of equipment or piping which would result in stresses in piping connections or misalignment of shafts or bearings. In order to meet this objective, maintain equipment and piping in a rigid position during installation. Do not transfer the load to the isolator until the installation is complete and under full operational load.
- D. Support the machine to be isolated with a structural steel frame.
- E. Provide brackets to accommodate the isolator and provide a mechanical stop. The vertical position and size of the bracket to be recommended by the isolator manufacturer.
- F. For restrained spring isolators, use housing as blocking during erection so that installed and operating heights can be the same. Maintain a minimum clearance of 1/2 inch around restraining bolts between housing and spring to avoid interference with spring action. Limit stops to be out of contact during normal operation.

3.2 HANGERS

- A. Install type 2 or 3 vibration isolation piping hangers where indicated in Equipment Mounting Schedule at the end of this section and within 20 feet (measured along piping) upstream and downstream of all pumps 3 HP or larger.
- B. Install the isolators with the isolator hanger box attached to or hung as close as possible to the structure.
- C. Suspend the isolators from substantial structural members, not from slab diaphragm unless specifically accepted.
- D. Align hanger rods to clear hanger box.

3.3 EQUIPMENT BASES

- A. Provide minimum operating clearance between the equipment frame or rigid steel base frame and the housekeeping pad or floor of 1 inch. Provide minimum operating clearance between concrete inertia base and the housekeeping pad or floor of 1 inch.

3.4 COIL BASES

- A. Mount floor supported coil section on a 1/4" thick layer of ribbed neoprene pad, with a 16 gauge galvanized steel plate between coil frame and pad. Coil shall be mounted on a concrete curb of sufficient height to allow coil drain pan to be sloped in two directions to drain pan bottom outlet with P-trap and/or refrigerant suction line traps to be installed without hitting floor.

3.5 FLEXIBLE PIPING CONNECTORS

- A. Provide flexible connectors for equipment that is supported by or mounted on vibration isolators except when connected piping is made up with a Victaulic Flex coupling system. Connectors to be installed under Section 232113.
- B. Hoses shall be installed on the equipment side of the shut-off valves and horizontally wherever possible.

- C. Provide connectors at pump suction and discharge, and elsewhere as required to accommodate thermal expansion, vibration and misalignment.
- D. Provide flexible connectors on all suction and discharge connections to all base mounted centrifugal pumps, vertical turbine pumps, air compressors, dryers, vacuum pumps or other equipment items producing vibration, shock, noise, or thermal motion of piping.
- E. Provide 300 psi companion flanges for connector for threaded, welded, soldered, or brazed piping as appropriate.
- F. Connectors to be aligned, centered, and shall not bear weight of pipe, fittings, or pipeline accessories such as valves. Piping shall be supported both sides of horizontal or vertical connectors.

3.6 PIPE FLOOR SUPPORTS

- A. Provide type 3 mountings with a minimum static deflection of 1.5 inches on horizontal pipe floor supported at slab in equipment rooms above grade.

3.7 SOUND ATTENUATORS

- A. Install in accordance with manufacturers' recommendations to obtain published performance.
- B. After installation, measure total system pressure before and after attenuators.
- C. If pressure loss exceeds maximum static pressure loss schedules on drawings: modify entrance or discharge aerodynamic flow to obtain specified performance.
- D. For maximum structural integrity, sound attenuator baffles should be installed in a vertical position; where this is not possible, structural reinforcement is required for attenuators wider than 24 in.
- E. When elbows precede attenuators, baffles shall be parallel to the plane of the elbow radius.

3.8 SOUND LININGS

- A. Dimensions of lined ductwork are clear inside dimensions after lining has been installed.
- B. Sound linings to be held in place with mechanical fasteners as per the latest SMACNA duct liner application standard, with joints and any tears to be coated with Benjamin Foster or accepted equal adhesive. The transverse joints to be coated prior to installation so that the ends of the liner are compressed together while the adhesive is still moist, forming a seal of the leading and trailing edge of each joint. Excess adhesive to be brushed to an even finish over the joint.
- C. Provide continuous sheet metal edge protectors at entering and leaving edges of lined duct sections where adjacent to unlined duct sections.

Extent of 1" ductwork sound linings:

1. Upstream of toilet/general exhaust fans and relief air fans, a minimum distance of 20'-0".
2. Transfer air ducts and shaft return stub ducts.

3. Return air elbow boots over ceiling grilles.
4. In all return and all rectangular exhaust ducts.

Extent of 1.5" ductwork sound linings:

1. Rectangular and round ductwork downstream of VAV boxes. Round ductwork to use JM Spiracoustic Plus, or equal.
2. In all low pressure rectangular supply ducting.
3. In plenums above supply diffusers.
4. Elsewhere when specifically indicated on drawings.
5. Do not install liner in duct serving evaporative cooled systems 10'-0" downstream of media.

D. Extent of plenum sound linings:

1. Mixed and outside air plenum walls and ceilings.
2. Supply air discharge and filter plenum walls and ceiling.
3. Return/Exhaust air plenums.
4. Return air plenum from riser to mixed air plenum.
5. Return/Exhaust air plenums inside packaged rooftop units when not factory installed.

E. Extent of perforated metal facing on sound linings:

1. In supply air fan discharge plenums.
2. In high velocity supply air ducts where shown on drawings.

3.9 SOUND PROOFING OF CONSTRUCTION

A. Required for opening between ductwork and piping and following construction:

1. Equipment room walls.
2. Floors, except in shafts.
3. Roofs, specifically inside roof curbs for mechanical equipment and where ductwork penetrates roof deck.

B. Sound proofing:

1. Fill openings with tightly packed fibrous glass blanket or board for full depth of penetration.
2. Caulk each side of opening with non-hardening, non-aging caulking compound.

3.10 EXTERNAL VIBRATION DAMPENING

A. For typical floor supply duct take-offs from main supply riser when required to meet specified sound levels, provide 1/8 inch thick duct exterior coating of vibration dampening compound. These treatments to be provided over the rectangular portion (flat sides) of the floor take-off ducts.

3.11 EXTERNAL SOUND BARRIER INSULATION

A. Provide foam composite, applied over the vane axial fan casings (both supply and return) extending from the inlet side of the intake sound traps, to the leaving side of the discharge sound traps, inclusive of all flexible connectors.

- B. Provide a duct enclosure of 2 layers of 5/8" gypsum board with staggered seams extending from the point that the ducts leave the rooftop unit or fan plenum to the leaving side of the discharge sound trap(s). A minimum clearance of 1" shall be maintained between the ductwork and the enclosure walls; all voids between the enclosure and the ductwork to be filled with loose batt fiberglass insulation. The points at which the ductwork penetrates the enclosure; the sheetrock is to be cut away from the ductwork by 1/4" to 1/2" and the void is to be filled with non-hardening caulk. Caulk shall be fire-rated if enclosure is required to be fire-rated.

3.12 EQUIPMENT MOUNTING SCHEDULE

- A. Manufacturer: Mason Industries, Inc., Kinetics, Vibro-Acoustics.
B. Schedule: See the following pages.

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	SLAB ON GRADE			20 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
REFRIGERATION EQUIPMENT						
A. Scroll Compressors	C	3	.75	C	3	.75
B. Scroll Condensing Units & Chillers	A	2	.25	A	4	.75
C. Hermetic Centrifugal Chillers	A	1	.25	A	4	.75
D. Open Centrifugal Chillers	C	1	.25	C	4	.75
E. Absorption Chillers	A	1	.25	A	4	.75
F. Screw or Rotary Chillers	A	1	.25	A	4	1.0
AIR COMPRESSORS						
A. Tank Mounted	A	3	.75	A	3	.75
B. Base Mounted	C	3	.75	C	3	.75
PUMPS						
A. Close Coupled – Base Mounted						
1. Up to 7 1/2 HP	B/C	2	.25	C	3	.75
2. 10 HP & Over	C	3	.75	C	3	.75

B. Flexible Coupled – Base Mounted						
1. Up to 40 HP	C	3	.75	C	3	.75
2. 50 to 125 HP	C	3	.75	C	3	.75
3. 150 HP & Over	(See Note 1)			(See Note 1)		
C. Vertical In-Line						
1. Up to 25 HP	A	1	.25	A	3	1.5
2. 30 HP & Over	A	1	.25	A	3	1.5

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	SLAB ON GRADE			20 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
COOLING TOWERS, FLUID COOLERS & EVAPORATIVE CONDENSORS						
A. Up to 300 RPM	(See Note 2)			(See Note 2)		
B. 301 to 500 RPM	A	1,2	.25	A	4	2.5
C. 501 RPM & Over	A	1,2	.25	A	4	.75
FANS						
AXIAL & TUBULAR FAN HEADS						
A. Up to 22 in. dia.	A/B	2	2.5	A/B	3	.75
B. 24 in. dia. & Over						
1. Up to 50 HP						
a. Up to 300 RPM	(See Note 2)			(See Note 2)		
b. 301 to 500 RPM	B/C	3	1.5	C	3	1.5
C. 501 RPM & Over	B/C	3	.75	C	3	1.5
2. 60 HP & Over	(See Note 1)			(See Note 1)		

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	SLAB ON GRADE			20 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
CENTRIFUGAL FANS & VENTILATION SETS						
A. Up to 22 in. Wheel dia.	A/B	2	.25	A/B	3	.75
B. 24 in. Wheel dia. & Over						
1. Up to 50 hp						
a. Up to 300 RPM	(See Note 2)			(See Note 2)		
b. 301 to 500 RPM	B	3	1.5	B	3	1.5
c. 501 RPM & Over	B	3	.75	B	3	.75
2. 60 HP & Over						
a. Up to 300 RPM	(See Note 2)			(See Note 2)		
b. 301 to 500 RPM	B/C	3	.75	C	3	1.5
c. 501 RPM & Over	B/C	3	.75	C	3	1.5
PACKAGED AIR HANDLING EQUIPMENT						
A. Up to 10 HP	A	2	.25	A	3	.75
B. 15 HP & Over	A	2	.25	A	3	.75

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	SLAB ON GRADE			20 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
PACKAGED ROOFTOP AIR CONDITIONING UNIT	--	--	--	D	3	.75
<p><u>BASE TYPES:</u></p> <p>A = NO BASE, ISOLATORS ATTACHED DIRECTLY TO EQUIPMENT B = STRUCTURAL STEEL RAILS OR BASE C = CONCRETE INERTIA BASE D = CURB-MOUNTED BASE</p> <p><u>ISOLATOR TYPES</u></p> <p>1 = RUBBER OR GLASS FIBER PAD 2 = RUBBER FLOOR ISOLATOR OR HANGER 3 = SPRING FLOOR ISOLATOR OR HANGER 4 = RESTRAINED SPRING ISOLATOR 5 = SPRING AND RUBBER IN SERIES HANGER</p> <p><u>NOTES:</u></p> <ol style="list-style-type: none"> CONTRACTOR SHALL PROVIDE VIBRATION ISOLATION AND CALCULATIONS STAMPED BY A LICENSED PROFESSIONAL ENGINEER. TO AVOID ISOLATOR RESONANCE PROBLEMS, SELECT ISOLATOR DEFLECTION SO THAT NATURAL FREQUENCY IS 40% OR LESS THAN LOWEST OPERATING SPEED OF EQUIPMENT (SEE ASHRAE HVAC APPLICATIONS HANDBOOK, 2007 EDITION). 						

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	30 FT. FLOOR SPAN			40 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
REFRIGERATION EQUIPMENT						
A. Scroll Compressors	C	3	1.5	C	3	1.5
B. Scroll Condensing Units & Chillers	A	4	1.5	A	4	2.5
C. Hermetic Centrifugal Chillers	A	4	1.5	A	4	1.5
D. Open Centrifugal Chillers	C	4	1.5	C	4	1.5
E. Absorption Chillers	A	4	1.5	A	4	1.5
F. Screw or Rotary Chillers	A	4	1.0	A	4	1.0
AIR COMPRESSORS						
A. Tank Mounted	A	3	1.5	A	3	2.5
B. Base Mounted	C	3	1.5	C	3	1.5
PUMPS						
A. Close Coupled – Base Mounted						
1. Up to 7 1/2 HP	C	3	.75	C	3	.75
2. 10 HP & Over	C	3	1.5	C	3	1.5
B. Flexible Coupled – Base Mounted						
1. Up to 40 HP	C	3	1.5	C	3	1.5
2. 50 to 125 HP	C	3	1.5	C	3	2.5
3. 150 HP & Over	(See Note 1)			(See Note 1)		
C. Vertical In-Line						
1. Up to 25 HP	A	3	1.5	A	3	1.5
2. 30 HP & Over	A	3	1.5	A	3	2.5

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	30 FT. FLOOR SPAN			40 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
COOLING TOWERS, FLUID COOLERS & EVAPORATIVE CONDENSORS						
A. Up to 300 RPM	(See Note 2)			(See Note 2)		
B. 301 to 500 RPM	A	4	2.5	A	4	2.5
C. 501 RPM & Over	A	1,2	1.5	A	4	1.5
FANS						
AXIAL & TUBULAR FAN HEADS						
A. Up to 22 in. dia.						
1. Up to 50 HP						
a. Up to 300 RPM	(See Note 2)			(See Note 2)		
b. 301 to 500 RPM	C	3	2.5	C	3	2.5
C. 501 RPM & Over	B/C	3	1.5	C	3	2.5
2. 60 HP & Over	(See Note 1)			(See Note 1)		

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	30 FT. FLOOR SPAN			40 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
CENTRIFUGAL FANS & VENTILATION SETS						
A. Up to 22 in. Wheel dia.	A/B	3	.75	A/C	3	.75
B. 24 in. Wheel dia. & Over						
1. Up to 50 hp						
a. Up to 300 RPM	(See Note 2)			(See Note 2)		
b. 301 to 500 RPM	B	3	1.5	B	3	2.5
c. 501 RPM & Over	B	3	.75	B	3	1.5
2. 60 HP & Over						
a. Up to 300 RPM	(See Note 2)			(See Note 2)		
b. 301 to 500 RPM	C	3	2.5	C	3	2.5
c. 501 RPM & Over	C	3	1.5	C	3	2.5
PACKAGED AIR HANDLING EQUIPMENT						
A. Up to 10 HP	A	3	.75	A	3	.75
B. 15 HP & Over	A	3	1.5	A	3	1.5

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	30 FT. FLOOR SPAN			40 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
PACKAGED ROOFTOP AIR CONDITIONING UNIT	A/B	3	1.5	A/B	3	2.5

BASE TYPES:

A = NO BASE, ISOLATORS ATTACHED DIRECTLY TO EQUIPMENT
 B = STRUCTURAL STEEL RAILS OR BASE
 C = CONCRETE INERTIA BASE
 D = CURB-MOUNTED BASE

ISOLATOR TYPES

1 = RUBBER OR GLASS FIBER PAD
 2 = RUBBER FLOOR ISOLATOR OR HANGER
 3 = SPRING FLOOR ISOLATOR OR HANGER
 4 = RESTRAINED SPRING ISOLATOR
 5 = SPRING AND RUBBER IN SERIES HANGER

NOTES:

- CONTRACTOR SHALL PROVIDE VIBRATION ISOLATION AND CALCULATIONS STAMPED BY A LICENSED PROFESSIONAL ENGINEER.
- TO AVOID ISOLATOR RESONANCE PROBLEMS, SELECT ISOLATOR DEFLECTION SO THAT NATURAL FREQUENCY IS 40% OR LESS THAN LOWEST OPERATING SPEED OF EQUIPMENT (SEE ASHRAE HVAC APPLICATIONS HANDBOOK, 2007 EDITION).

END OF SECTION 230540

**SECTION 230548
MECHANICAL SEISMIC CONTROL**

1.1 WORK INCLUDED

- A. Anchorage and seismic restraint systems for all Division 23 isolated and non-isolated equipment, ductwork and piping systems.
- B. All Division 22 and 23 equipment/piping/ductwork shall be isolated and/or seismically supported in accordance with all requirements of the IBC and ASCE 7. This includes, but is not limited to, the following:

- | | |
|-------------------------------|-----------------------------|
| 1. Piping | 15. Heat Exchangers |
| 2. Ductwork | 16. Air Handling Units |
| 3. Sound Attenuators | 17. Domestic Water Heaters |
| 4. Unit Heaters | 18. Chillers |
| 5. Boilers | 19. Refrigerant Compressors |
| 6. Air Separators | |
| 7. Expansion Tanks | |
| 8. Condensers | |
| 9. Supply Air Fans | |
| 10. Hanging Exhaust Fans | |
| 11. Pumps | |
| 12. Glycol Tanks/Pumps | |
| 13. Fan Coil Units | |
| 14. Chemical Treatment Stands | |

1.2 RELATED WORK

- A. Requirements: Provide Mechanical Seismic Control in accordance with the Contract Documents.
- B. Section 230500 - Basic Mechanical Requirements.
- C. Section 230529 - Basic Mechanical Materials and Methods.
- D. Section 230540 - Mechanical Sound and Vibration Control.

1.3 REFERENCES

- A. International Building Code, Current Edition in use by Jurisdictional Authority.
- B. NFPA Bulletin 90A, Current Edition.
- C. UL Standard 181.
- D. SMACNA Seismic Restraint Manual: Guidelines for mechanical systems.

1.4 SYSTEM DESCRIPTION

- A. The Division 23 Contractor shall be responsible for supplying and installing equipment, vibration isolators, flexible connections, rigid steel frames, anchors, inserts, hangers and attachments, supports, seismic snubbers and bracing to comply with the following:
1. Short period design spectral response acceleration coefficient $S_{DS} = 1.261 G$.
 2. One-second period design spectral response acceleration coefficient $S_{D1} = 0.698 G$.
 3. Site Class E.
 4. Seismic Design Category D.
- B. The following components have a component importance factor I_P of 1.5:
1. Fire Sprinkler Protection System
 2. Natural Gas Piping

All other components have an importance factor I_P of 1.0.

1.5 QUALITY ASSURANCE

- A. All supports, hangers, bases, anchorage and bracing for all isolated equipment and non-isolated equipment shall be designed by a professional engineer licensed in the state where the project is located, employed by the restraint manufacturer, qualified with seismic experience in bracing for mechanical equipment. Shop drawings included with deferred submittal for earthquake bracing and anchors from the restraint manufacturer shall bear the Engineer's signed professional seal. All calculations/design work required for the seismic anchorage and restraint of all Division 23 equipment and systems shall be provided by a single firm.
- B. The above qualified professional engineer shall determine specific requirements for equipment anchorage and restraints, locations and sizes based on shop drawings for the mechanical equipment which have been submitted, reviewed and accepted by the Architect/Engineer for this project.
- C. Seismic Engineer or the Engineer's Representative shall field inspect final installation and certify that bracing and anchorage are in conformance with the Seismic Engineer's design, the requirements of this specification section, and all seismic restraint requirements of the building code. Provide a Certificate of Compliance stating all Division 22 and 23 utilities and equipment have been anchored and restrained in accordance with the requirements of the building code and ASCE 7. A certificate of compliance shall include the Seismic Engineer's signed Professional Engineer's seal. Include a copy of the certificate in each copy of the Operation and Maintenance Manual.
- D. The Division 23 Contractor shall require all equipment suppliers to furnish equipment that meets the seismic code, with bases/skids/curbs designed to receive seismic bracing and/or anchorage. All isolated and non-isolated mechanical equipment bracing to be used in the project shall be designed from the equipment submittals and certified to be code-compliant by the equipment manufacturer for seismic description loads defined above, with direct anchorage capability.

1.6 SUBMITTALS

- A. A single submittal shall be provided for all seismic anchorage and restraints for all Division 23 equipment and systems provided as part of this project. Individual submittals for specific systems will not be accepted.
- B. Submit shop drawings, calculations, and printed data for the following items under provisions of the General Conditions of the Contract:
 - 1. Complete engineering calculations and shop drawings for all seismic restraint requirements for all equipment as required by the IBC.
 - 2. The professional seal of the engineer who is responsible for the design of the Seismic Restraint System.
 - 3. Details for all seismic bracing.
 - 4. Details for steel frames, concrete inertia bases, and housekeeping pads. Include dimensions, embed depths, dowelling details, and concrete reinforcing requirements.
 - 5. Clearly outlined procedures for installing and adjusting the isolators, seismic bracing anchors, snubbers, cables, and bolt connections.
 - 6. Floor plan noting the locations, size, and type of anchorage and restraint to be used.
 - 7. Include confirmation that all calculations are based on the design criteria listed in Paragraph 1.4.A of this Section.
 - 8. Certificate of Compliance.

PART 2 PRODUCTS

2.1 RESTRAINT EQUIPMENT AND SYSTEMS

- A. Acceptable Manufacturers and Suppliers for Non-Isolated Systems:
 - 1. Mason Industries, Inc.
 - 2. Korfund
 - 3. Amber/Booth Company
 - 4. Vibration Mountings and Control Company
 - 5. Kinetics
 - 6. International Seismic Application Technology
 - 7. Tolco
 - 8. Vibro Acoustics
 - 9. Hilti
 - 10. Vibration & Seismic Technologies
- B. Manufacture of restraints and anchors for isolated equipment required by this specification section shall also furnish the vibration isolators required by Specification Section 230540.

2.2 SNUBBERS

- A. Snubbers shall be all-directional and consist of interlocking steel members restrained by replaceable shock absorbent elastomeric materials a minimum of 3/4 inch thick.
- B. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8 inch or more than 1/4 inch.

- C. Snubbers shall be Mason Industries Z - 1011 or accepted equivalent.

PART 3 EXECUTION

3.1 DESIGN AND INSTALLATION

A. General:

1. All mechanical equipment, piping and ductwork shall be braced, anchored, snubbed or supported to withstand seismic disturbances in accordance with the criteria of this specification. Provide all engineering, labor, materials and equipment for protection against seismic disturbances as specified herein. The following mechanical components are exempt from seismic restraint requirements:
 - a. Components in Seismic Design Categories A and B.
 - b. Components in Seismic Design Category C that have an importance factor I_P of 1.0.
 - c. Components that have an importance factor I_P of 1.0, that are mounted less than four feet above the floor, that weigh less than 400 pounds, and that have flexible ductwork, piping, and conduit connections.
 - d. Components that have an importance factor I_P of 1.0, that weigh 20 pounds or less, and that have flexible ductwork, piping, and conduit connections.
2. Powder-actuated fasteners (shot pins) shall not be used for component anchorage in tension applications in Seismic Design Category D, E, or F.
3. Attachments and supports for mechanical equipment shall meet the following provisions:
 - a. Attachments and supports transferring seismic loads shall be constructed of materials suitable for the application and designed and constructed in accordance with a nationally recognized structural code such as, when constructed of steel, AISC, Manual of Steel Construction (Ref. 9.8-1 or 9.8-2).
 - b. Friction clips shall not be used for anchorage attachment.
 - c. Expansion anchors shall not be used for mechanical equipment rated over 10 hp (7.45 kW). Exception: Undercut expansion anchors.
 - d. Drilled and grouted-in-place anchors for tensile load applications shall use either expansive cement or expansive epoxy grout.
 - e. Supports shall be specifically evaluated if weak-axis bending of light-gauge support steel is relied on for the seismic load path.
 - f. Components mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction. The design force shall be taken as $2F_p$. The intent is to prevent excessive movement and to avoid fracture of support springs and any non-ductile components of the isolators.
 - g. Seismic supports shall be constructed so that support engagement is maintained.

- B. Install ceiling mounted items in accordance with ASTM C 636.
1. Ceiling mounted air terminals or services weighing less than 20 pounds shall be positively attached to the ceiling suspension main runners or to cross runners with the same carrying capacity as the main runners.
 2. Terminals or services weighing 20 pounds but not more than 56 pounds, in addition to the above, shall have two No. 12 gauge hangers connected from the terminal or service to the ceiling system hangers or to the structure above. These wires may be slack.
 3. Terminals or services weighing more than 56 pounds shall be supported directly from the structure above by approved hangers.
- C. Spring Isolated Equipment:
1. All vibration isolated equipment shall be mounted on rigid steel frames or concrete bases as described in the vibration control specifications unless the equipment manufacturer certified direct attachment capability. Each spring mounted base shall have a minimum of four all-directional seismic snubbers that are double acting and located as close to the vibration isolators as possible to facilitate attachment both to the base and the structure. Snubbers shall be installed with factory set clearances.
- D. Non-Isolated Equipment:
1. The Division 230548 Contractor shall be responsible for thoroughly reviewing all drawings and specifications to determine all equipment to be restrained. This Contractor shall be responsible for certifying that non-isolated equipment is mounted and braced such that it adheres to the system description criteria in this specification section.
- E. Piping:
1. Seismic braces for piping may be omitted when the distance from the top of the pipe to the supporting structure is 12" or less. Where pipes are supported by a trapeze, seismic braces may be omitted when the trapeze shall be supported by hangers having a length of 12" or less.
 2. A rigid piping system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: Wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
 3. Unbraced piping attached to in-line equipment shall be provided with adequate flexibility to accommodate differential displacements.
 4. At the interface of adjacent structures or portions of the same structure that may move independently, utility lines shall be provided with adequate flexibility to accommodate the anticipated differential movement between the ground and the structure.
 5. Provide large enough pipe sleeves through walls or floors to allow for anticipated differential movements.

F. Ductwork:

1. Seismic restraints are not required for HVAC ducts with importance factor I_P of 1.0, provided that either of the following conditions are met for the full length of each duct run:
 - a. HVAC ducts are suspended from rod hangers and hangers are 12 inches or less in length from the point rod attaches to duct, to the point rod connects to the supporting structure. Rods must be secured to both top and bottom cross angles with locking nuts above and below angle iron.
 - b. HVAC ducts have a cross-sectional area of less than 6 square feet.
 - c. This exception is not valid if the top of ductwork is not secured to hanger rods to limit pendulum length to 12 inches.
2. Equipment items installed in-line with the duct systems with an operating weight greater than 75 pounds shall be supported and laterally braced independently of the duct system.

END OF SECTION 230548

**SECTION 230593
TESTING, ADJUSTING AND BALANCING**

PART 1 GENERAL

1.1 RELATED WORK

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these Documents.
- B. Related work specified in other Sections:

Section 230500 - Basic Mechanical Requirements
Section 233300 – Ductwork and Accessories

1.2 SYSTEM DESCRIPTION

- A. The work includes, but is not limited to the following:
 - 1. Upon completion of the installation of all the plumbing, air and heating or cooling water systems glycol systems, all necessary adjustments shall be made to provide capacities listed on the Drawings to properly balance these systems.
 - 2. Submittals and written reports as specified.
 - 3. Testing requirements as described in Specification Section 230500, paragraph 1.16.
 - 4. Witness duct leakage test required by Specification Section 233300 – Ductwork and Accessories.
 - 5. Provide assistance, in cooperation with the various trades, in the final adjustments and test of the Life Safety Systems to comply with the requirements of the Building and Fire Departments.
 - 6. Provide Owner training as described in Specification Section 230500.

1.3 QUALITY ASSURANCE

- A. Work under this section shall be executed under the direct supervision of a Registered Professional Engineer having an established professional office in the State of Utah and having an experience record of not less than five (5) years in the mechanical contracting industry, engaged in testing, balancing and adjusting of air and hydronic mechanical systems for not less than two (2) years of that time, or, under the direct supervision of a qualified testing, adjusting and balancing supervisor, possessing certification from the National Environmental Balancing Bureau (NEBB) or from the Associated Air Balance Council (AABC).
- B. Comply with the applicable procedures in the chapter on Testing, Adjusting and Balancing in the latest ASHRAE Edition of the NEBB, AABC, and SMACNA Test and Balance documents.
- C. Calibration and maintenance of instruments shall be in accordance with manufacturer's standards and recommendations, and calibration histories for each instrument shall be available for examination.
- D. Accuracy of measurements shall be in accordance with the applicable measurement means as listed in the latest edition of NEBB, AABC, and SMACNA Test and Balance documents.

- E. Allowable Tolerances:
 - 1. Tolerances of adjustment for air handling systems are plus or minus 10% for supply, return, and exhaust systems at air devices and plus 10%/minus 0% at all fans/source equipment from figures shown on drawings.
 - 2. Tolerances of adjustment for hydronic systems, are plus or minus 10% of design conditions shown on drawings at terminal devices and equipment, and plus 10%/minus 0% at all pumps.

- F. Final Testing, Adjusting and Balancing of all hydronic and air systems shall be performed by an approved separate professional Testing, Adjusting and Balancing subcontractor meeting the above Quality Assurance requirements. Acceptable separate professional subcontractors approved to work on this project are as follows:
 - 1. BTC Services, Inc.
 - 2. Certified Testing & Balancing, Inc.
 - 3. RS Analysis, Inc.
 - 4. Bonneville Test & Balance
 - 5. Independent Test & Balance, LLC
 - 6. Intermountain Test & Balance
 - 7. Mechanical Testing Corporation

- G. Subcontractors not listed above must submit for acceptance.

- H. Within 30 days after execution of the Owner-Contractor Agreement, transmit to Architect/Engineer the name and qualifications of the organization proposed to perform the services.

1.4 SUBMITTALS

- A. Procedure: Submit Qualifications, Documentation, Test Schedules and Reports in accordance with the General Conditions of the Contract.

- B. Qualifications:
 - 1. Submit three copies of documentation to confirm compliance with Quality Assurance provisions:
 - a. Organization supervisor and personnel training and qualifications.
 - b. Specimen copy of each of the report forms proposed for use.

- C. Preliminary Report: At least fifteen days prior to starting field work, submit three copies of:
1. A set of report forms filled out as to the design flow values and the installed equipment pressure drops, and the required CFM for air terminals.
 2. A complete list of instruments proposed to be used, organized in appropriate categories, with data-sheets for each. Show:
 - a. Manufacturer and model number.
 - b. Description and use when needed to further identify the instrument.
 - c. Size of capacity range.
 - d. Latest calibration date.
 3. Architect/Engineer will review submittals for compliance with Contract Documents, and will return one set marked to indicate:
 - a. Discrepancies noted between measured data and Contract Documents.
 - b. Additional, or more accurate, instruments required.
 - c. Requests for re-calibration of specific instruments.
- D. Schedules:
1. Schedule tests to comply with project completion schedules.
 2. Schedule testing and balancing of parts of the systems which are delayed due to seasonal, climatic, occupancy, or other conditions beyond control of the Contractor, as early as the proper conditions will allow, after consultation with Architect/Engineer.
 3. Submit reports of delayed testing promptly after execution of those services.
- E. Final Report: At least fifteen days prior to Contractor's request for final inspection, submit three copies of final reports, on applicable reporting forms, for review. Submit a fourth copy directly to the Engineer. Each individual final reporting form must bear the signature of the person who recorded data and that of the NEBB or AABC certified supervisor of the reporting organization. Identify instruments of all types which were used and last date of calibration of each. Report shall include:
1. A detailed letter to Engineer outlining all abnormal or notable conditions not covered in above data specifically identifying all locations where specified flow tolerances could not be met.
 2. A set of reduced black and white or blue line prints with all air openings clearly marked to correspond with data sheets and with thermometer locations clearly marked.
 3. Data sheets showing amount of air handled at each opening, instrument used, velocity readings, and manufacturer free area factor.
 4. Data sheets giving log of room temperatures in rooms exhibiting objectionable temperatures during the heating season. Logs shall be taken when outside temperature is 30 deg.F or colder.
 5. Data sheets giving log of room temperatures in rooms exhibiting objectionable temperatures during the cooling season. Logs shall be taken with full occupant load, full lighting, and maximum solar conditions.

6. Equipment data sheets giving make, size and model, of fans, starters and motors with rated amps and service factors, and drives. Include pumps, supply fans, exhaust and recirculating fans.
7. Operating data including fan RPM, inlet and outlet pressures, pressure drop across filters, face and bypass dampers, and measured motor current and voltage, BHP and CFM (total).
8. Heating equipment operating data including air temperatures entering and leaving heating coils (maximum air temperature rise), together with corresponding air flow and air pressure drop, water temperature entering and leaving heating coil, water flow and pressure drop through heating coil.
9. Cooling equipment operating data including air temperatures entering and leaving cooling coils together with corresponding air flow and air pressure drop, water temperature entering and leaving cooling coil, and water flow and pressure drop through cooling coil.
10. Cooling tower operating data including measurements of hot water, cold water and wet-bulb temperatures, circulating water flow rate, fan RPM, fan power and wind velocity.
11. Equipment and operating data as required to show performance of pumps, heat exchangers, domestic hot water circulating systems, heating, ventilating, and air conditioning units, cabinet heaters, unit heaters, unit ventilators, fans and temperature control devices.
12. Sound pressure levels showing readings in all 8 octave bands and plotted on RC(II) charts shall be submitted for the following:
 - a. All sides of Mechanical Rooms.
 - b. Lobbies, Labs, and Commercial Area.
 - c. Conference Rooms.
 - d. Spaces within 20 ft. of parking garage ventilation fan inlets and outlets.
 - e. All spaces exhibiting abnormally high or annoying noise levels.
13. Domestic hot water recirculation data including flow at each branch shown requiring specific flow, and at the pump.

1.5 PROJECT CONDITIONS

- A. The following job conditions must be verified before any testing, adjusting or balancing of the environmental systems begin:
 1. Installation of the designated system is complete and in full operation.
 2. On hydronic systems, strainers shall be cleaned, temperature control valve operation shall be checked, pump rotation shall be checked, pressure reducing valves shall be adjusted, and other such conditions requiring correction.
 3. Air systems shall be checked for dirty filters, filter leakage, equipment vibrations, damper operation, fan rotation, and other such conditions requiring correction.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PROCEDURE

- A. Confirm that project conditions have been verified and that necessary corrections have been made before proceeding with the Work.
- B. The Test and Balance Contractor must proportion air/water flows in the system while introducing a minimum amount of resistance. All systems are to be proportionally balanced.
- C. Hydronic Systems:
 - 1. Using system flow meters and/or contact pyrometer, the balancing firm shall adjust the quantity of water or glycol solution handled by each pump and supplied to each coil, solar collector, heat exchanger, cooling tower, and such other primary source equipment to meet design requirements, and mark each balancing cock at final setting.
- D. Air Systems:
 - 1. The balancing firm shall adjust all dampers, diffusers, registers, belts and sheaves for the delivery and distribution of air quantities shown in the Contract Documents and shall mark each balancing device at final setting.
 - 2. Adjust fan speeds and motor drives within drive limitations for required air volume, provide new sheaves as necessary, or adjustable bands on constant volume plenum fans, and notify Division 26 Contractor of any thermal overloads that need to be changed/replaced.
 - 3. Measure static air pressure conditions on air supply units, including individual filter and coil pressure drops, and total pressure across the fan. Make allowances for 0.5" w.c., equivalent to 50% loading of filters.
 - 4. Exhaust and recirculation air systems shall be adjusted for air quantities shown on Drawings.
 - 5. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
 - 6. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
 - 7. Measure building static pressure in both economizer mode and minimum outside air mode, and adjust supply, return and exhaust air systems to provide the required relationship between each to maintain approximately 0.05 inches water column positive static pressure at the Building Entries.
 - 8. Distribution system shall be adjusted to obtain uniform space temperatures free from objectionable drafts and noise.
 - 9. Where multiple air diffusers are shown on one terminal box, adjust dampers for the delivery and distribution of air quantities shown in the Contract Documents.
 - 10. Multi-zone units are to be checked for motorized damper leakage. Air quantities are to be adjusted with all mixing dampers set first for cooling, then heating, then modulating. If it is significantly higher for heating or cooling, measure motor current and adjust fan speed for heating.
 - 11. Set all VAV boxes at minimum/maximum air flow shown on drawings.
 - 12. Adjust air flow switches for proper operation on all fan powered VAV boxes.

13. Report: After all adjustments are made, a detailed report shall be prepared by the balancing firm and submitted to the Architect for approval. Owner reserves the right to spot check the report prior to final acceptance.

E. Plumbing System

1. Hot Water Recirculation Systems: Set flow at each balancing valve shown. Record flow at each pump. Verify the proper installation of automatic flow control valves.

END OF SECTION 230593

**SECTION 230700
MECHANICAL INSULATION**

PART 1 GENERAL

1.1 RELATED WORK

- A. Requirements: Provide insulation in accordance with the Contract Documents.
- B. Related work specified in other Sections:

- Section 224450 - Plumbing Equipment
- Section 230500 - Basic Mechanical Requirements
- Section 230529 - Basic Mechanical Materials and Methods
- Section 230540 - Mechanical Sound and Vibration Control
- Section 232113 - HVAC Piping & Specialties
- Section 233100 - Air Distribution
- Section 235216 - Condensing Boilers
- Section 235700 - Heat Transfer
- Section 236400 - Refrigeration

1.2 SYSTEM DESCRIPTION

- A. The mechanical insulation work required by this Section shall include materials and methods as described herein and on the Drawings and as required by applicable energy codes.
- B. The work includes, but is not limited to providing insulation on the following:
 - 1. Plumbing Systems:
 - Domestic Hot Water-Supply, Recirculating, Hot Water Converters, and Storage Tanks
 - Tempered Domestic Water-Supply, Recirculating and Storage Tanks
 - Tempered Domestic Water Circulating
 - Domestic Cold Water
 - Primary Roof Drain System
 - Overflow Roof Drain Bowls
 - Chilled Drinking Water Piping, Recirculating and Storage Tanks

2. Heating Systems:
 - Heating Water Supply and Return
 - Heat Exchangers, Converters and Air Separators
 - Thermal Storage Tanks
 - Boiler Feed Water
 - Boiler Feed Water Storage Tanks
 - Blowdown Separator Tank & Vent
 - Blowdown Discharge Piping
 - Flue Gas Breeching and Single Wall Stacks
 - Stacks to Roof
 - Boiler and Flue Boxes
3. Chilling Systems:
 - Chilled Water
 - Air Separators
 - Condenser Water
 - Refrigerant Suction
 - Refrigerant Hot Gas
 - Chilled Water Pump Bodies
4. Refrigerant Systems:
 - Refrigerant Piping
5. Air Distribution Systems:
 - Exterior surfaces of all plenums and ducts which are a part of the following systems where duct or plenum is not lined (see Section 230540):
 - Outside Air
 - Combustion Air
 - Mixed Air
 - Medium Pressure Supply Air
 - Low Pressure Supply Air
 - Return Air
 - Rigid Round Runouts to Diffusers
6. Other Systems:
 - Cold Condensate Drains
 - Piping Exposed to Freezing with Heat Trace.

1.3 QUALITY ASSURANCE

- A. Qualifications: The firm executing the work of this Section shall have at least 3 years successful installation experience on projects with mechanical insulations similar in scope and nature to that required for this Project.
- B. Requirements of Regulatory Agencies: All insulation shall be in accordance with Jurisdictional Building Code and State and Federal Energy Conservation Standards.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications and installation instructions for each type of mechanical insulation in accordance with the General Conditions of the Contract. Include schedule showing manufacturer's product number, thickness and furnished accessories for each mechanical system requiring insulation.
- B. Provide schedule of pipe sizes with insulation thickness at corresponding fluid temperatures.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery of Materials: Deliver insulation, coverings, adhesives, and coatings to site in containers with manufacturer's stamp or label affixed showing fire hazard ratings of products.
- B. Storage of Materials: Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged insulation; remove from project site.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers of insulation materials shall be as follows:

- 3M/Thermal Ceramics (FireMaster)
- Armstrong
- Certain-teed
- Dow Chemical
- Gilsulate International, Inc. (Gilsulate 500XR Loose-Fill Insulation)
- Johns Manville
- Knauf
- Manson Insulation Products
- Owens-Corning
- Renler (Pyroscat FastR Wrap)
- SpecSeal (Claymac)
- Unifrax (Fyrewrap)

2.2 MATERIALS

A. Conductivity:

TYPE OF INSULATION	MAXIMUM THERMAL CONDUCTIVITY/INCH
Calcium Silicate	0.47 at 600 degrees Fahrenheit
Glass Fiber Pipe Insulation	0.25 at 75 degrees Fahrenheit
Glass Fiber Rigid Equipment Insulation	0.25 at 75 degrees Fahrenheit
Glass Fiber Rigid Duct Insulation	0.24 at 75 degrees Fahrenheit
Glass Fiber Blanket Duct Insulation	0.29 at 75 degrees Fahrenheit
Expanded Polystyrene	0.24 at 75 degrees Fahrenheit
Ceramic Fiber Grease Duct Wrap	0.25 at 70 degrees Fahrenheit
Polyisocyanurate Foam	0.19 at 75 degrees Fahrenheit
Granular Loose Fill	See below

B. Duct Wrap: Blanket-type fiberglass insulation 1-1/2" thick, 0.75 pounds per cubic foot density.

C. Vapor Barrier Coatings: To have a perm rating not more than 0.25 when tested in accordance with ASTM E96, procedure A.

D. Adhesives, Sealers, Facings and Vapor Barrier Coatings: To be compatible with materials to which applied, and shall not corrode, soften, or otherwise attack the pipe or insulation materials in either the wet or dry state. Use only adhesives, sealers, facings, and vapor barrier coatings as recommended by the manufacturer of insulation materials.

E. Chemicals for Treating Paper: Non-soluble.

F. Non-Collapsing Inserts: Calcium Silicate or Polyisocyanurate (Dow Trymer 2000). No Polystyrene inserts are allowed.

G. Granular, Loose-Fill Insulation: Inorganic, nontoxic, nonflammable, sodium potassium aluminum silicate with calcium carbonate filler. Include chemical treatment that renders insulation hydrophobic.

1. Thermal Conductivity (k-Value): 0.60 at 175 deg F and 0.65 at 300 deg F.
2. Application Temperature Range: 35 to 800 deg F.
3. Dry Density: 40 to 42 lb/cu. ft.
4. Strength: 12,000 lb/sq. ft.

2.3 PERFORMANCE CRITERIA

A. Insulation and accessory materials to meet the following criteria:

1. Insulation Materials: To be noncombustible as defined in National Fire Protection Association Pamphlet 220 and to be Underwriter's Laboratory listed.

2. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread rating of 25 or less, and smoke-developed rating of 50 or less, as tested by ANSI/ASTM E 84 (NFPA 255) method.

2.4 HANDICAP LAVATORY INSULATION

- A. Insulation System: Molded closed cell insulation, 3/16-inch nominal wall thickness; provide pre-molded fittings to completely cover tail piece, P-trap, trap arm, hot and cold water supply stop valves and exposed supply tubing; include nylon fasteners for all fittings.
- B. Handi Lav-Guard manufactured by Truebro; Trap Wrap manufactured by Brocar Products; Zeston Snap-Trap manufactured by Johns Manville or approved equal.
- C. Install at all handicap accessible lavatories installed in this project.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Testing of piping and ductwork to be completed prior to application of insulation.
- B. Apply insulation tightly over clean, dry surfaces with sections or edges firmly butted together.
- C. Make insulation continuous through sleeves or openings in walls and floors.
- D. Run sealed vapor barriers continuous throughout all cold surface insulation systems.
- E. Avoid the use of staples on vapor barrier jackets. Seal all vapor barrier penetrations with white vapor barrier sealant.
- F. Apply adhesives so as not to exceed the coverages recommended by the manufacturers.
- G. Leave surfaces clean and ready for painting.
- H. Do not insulate cleanouts, access openings or identification plates. Neatly bevel insulation and finishes up to the edges of such openings and stop with sheet metal rings.
- I. Provide non-collapsing inserts between pipe and all shields/saddles on all insulated piping 2" and larger.

3.2 SPECIFIC INSTALLATION REQUIREMENTS

A. Minimum Pipe Insulation Schedule:

International Energy Conservation Code

PIPE INSULATION THICKNESS IN INCHES*			
Fluid	Nominal Pipe Diameter		
	< 1.5"	≥ 1.5"	≥ 8"
Heating Water	1.5	2.0	2.0
Domestic Hot, Tempered, and Circulating Water.	1.0	1.5	1.5
Chilled Water/Glycol, Refrigerant	1.0	1.0	1.5

*Based on insulation having a conductivity not exceeding 0.27 BTU per inch/h·ft²·°F.

Exceptions:

1. Factory installed piping within HVAC equipment tested and rated in accordance with IECC referenced procedures.
2. Strainers, control valves, and balancing valves associated with piping 1-inch or less in diameter on heating water, domestic hot water, domestic tempered hot water, and domestic hot water circulating systems.

DUCT AND PLENUM INSULATION	
Location	Min. Insulation Value
In unconditioned spaces (i.e. ceiling spaces or unheated spaces)	R-6
Outside building envelope	R-12

Exceptions:

- a. When located within equipment.

B. Plumbing System:

1. Domestic Cold Water:

All piping and where freeze protection is required, one-half inch thick fiberglass pipe covering with all service jacket self-seal lap.

All domestic cold (PEX) piping to be insulated to maintain fire/plenum rating where used in air plenums.

2. Roof Drains:

Horizontal mains and vertical from horizontal to and including drain bowls, one-half inch thick fiberglass pipe covering with all service jacket self-seal lap.

Overflow roof drain bowls shall be insulated but not overflow drain piping. Vertical mains shall be insulated.

3. Domestic Hot and Tempered Supply and Circulating Water:

Insulate entire system.
Thicknesses per table of 230700-3.2, A.
4. Domestic Hot Water Heaters, Storage Tanks, and Accumulators (not factory insulated):

Two inch thick fiberglass board, foil faced or faced with Du-All tank wrap or equal. Finish with six-ounce canvas or fiberglass reinforcing mesh and fire retardant lagging adhesive.
5. Domestic Cold Water Storage Tanks:

Two inch thick fiberglass board foil faced or faced with Du-All tank wrap or equal. Seal all joints with vapor barrier mastic. Finish with six-ounce canvas or fiberglass reinforcing mesh and fire retardant vapor barrier mastic.
6. Chilled Drinking Water:

Thicknesses per Chilled Water Piping System, 40-55 deg. F., of 230700-3.2 A.
7. Fittings:

Premolded PVC fitting covers with Fiberglass insert. PVC covers shall be rated for return air plenum use.
8. Valves:

All systems: Oversized pipe covering of same material and thickness as adjacent pipe covering. Finish with six-ounce canvas and heavy coat of vapor barrier mastic coating.

C. Heating System:

1. Heating Water Supply and Return:
 - a. Fiberglass pipe covering with all-service jacket and self-seal lap.
 - b. Thicknesses per Minimum Pipe Insulation Schedule in Section 230700-3.2, A.
 - c. Heat exchangers, convertors, air separators, storage tanks and receivers:

351 deg. and up 4" thick
251 deg. - 350 deg..... 3" thick
up to 250 deg..... 2" thick

Fiberglass pipe covering or Du-All pipe and tank wrap with all service jacket. Finish with six-ounce canvas or fiberglass reinforcing mesh applied with heavy coat of lagging adhesive where subject to abuse.

2. Fittings:
 - a. Premolded PVC fitting covers with Fiberglass insert.
3. Valves:
 - a. All systems: Oversized pipe covering of same material and thickness as adjacent pipe covering. Finish with six-ounce canvas or fiberglass reinforcing mesh and heavy coat of vapor barrier mastic coating.
4. Boiler Breechings, Drum Heads, Flue Boxes, Draft Fan Scrolls, Fly Ash Separators and Stacks to Roof:
 - a. Insulate with 3" thick fiber glass insulation with 650 deg. F. temperature limit, all-service jacket and lap seal.

OR

- a. Insulate with 1-1/2" thick rigid hydrous calcium silicate equipment insulation. Secure insulation to metal surfaces with stick-clips on 12" centers and wire in place with 14 gauge galvanized annealed steel wire or 1/2" wide by .015" thick galvanized steel bands on 12" maximum centers. Cover all surfaces with 1" galvanized wire mesh and fasten to wires or bands with all edges laced together. Apply a 1/2" thickness of insulating cement in two coats troweled to a smooth finish. Cover with pre-sized glass cloth adhered with lagging adhesive. Finish with a thick coat of white lagging adhesive.

- D. Chilling System:
1. Fiberglass pipe covering with all service jacket self-seal lap.
 2. Chilled Water Supply and Return: Thicknesses per Chilled Water Piping System of Section 230700-3.2 A.
 3. Condenser Water: Thicknesses per Chilled Water Piping System of Section 230700-3.2 A.
 4. Fittings:

All systems: Premolded PVC fitting covers with fiberglass insert. Seal all fittings at end and throat.
 5. Valves:

All systems: Oversized pipe covering of same material and thickness as adjacent pipe covering. Finish with six-ounce canvas or fiberglass reinforcing mesh and heavy coat of vapor barrier mastic coating.
 6. Cold Condensate Drain Piping:

1/2" thickness fiberglass pipe covering with all service jacket self-seal lap.

7. Chilled Water Pump Bodies:
 - a. Chilled water pump bodies shall be insulated with 1-inch thick flexible expanded elastomeric insulation, install to allow for maintenance access to pump.

OR
 - a. Apply a minimum coating thickness of 1/32" over all cold surfaces of the pump(s) with an anti-condensation coating to prevent sweating and dripping. Acceptable products: AQUABAN (chemicoat.com), or approved equal.
 8. Refrigerant Suction and Liquid Piping: Thicknesses per Refrigerant Piping System of Section 230700 - 3.2, A.

Fiberglass pipe covering with all service jacket self-seal lap. At Contractor's Option, a closed cell insulation with all joints butted and cemented may be used in lieu of fiberglass. Armaflex 22 or equal. If closed cell insulation is exposed to sunlight, coat all surfaces with UV protection to prevent long term deterioration from sunlight.
 9. Refrigerant Hot Gas Piping:

1" thickness fiberglass pipe covering with all service jacket self-seal lap, or 3/4" thick closed cell insulation. This is for safety purposes only, not for thermal efficiency.
 10. Cold Water Thermal Storage Tanks and Chilled Water Storage Tanks:

2" thick fiberglass board, foil faced or faced with Du-All pipe and tankwrap. Seal all joints with vapor barrier mastic. Finish with six-ounce canvas or fiberglass reinforcing mesh and fire retardant vapor barrier mastic.
- E. Buried Piping:
1. Do not disturb the bottom of trench, or compact and stabilize it to ensure proper support.
 2. Remove any standing water in the bottom of trench.
 3. Form insulation trench by excavation or by installing drywall side forms to establish required height and width of the insulation.
 4. Support piping with proper pitch, separation, and clearance to backfill or side forms using temporary supporting devices that can be removed after back filling with insulation.
 5. Place insulation and backfill after field quality-control testing has been completed and results approved.
 6. Apply bitumastic coating to carbon-steel anchors and guides. Pour concrete thrust blocks and anchors.
 7. Wrap piping at bends, expansion loops, and offsets with mineral-wool insulation of thickness appropriate for calculated expansion amount.
 8. Pour loose-fill insulation to required dimension agitating insulation to eliminate voids around piping.
 9. Remove temporary hangers and supports.

10. Cover loose-fill insulation with polyethylene sheet a minimum of 4 mils (0.10 mm) thick, and empty loose-fill insulation bags on top.
11. Manually backfill 6 inches (150 mm) of clean backfill. If mechanical compaction is required, manually backfill to 12 inches (300 mm) before using mechanical-compaction equipment.

F. Refrigerant/Brine System:

1. Expanded polystyrene pipe covering with all service jacket and self-seal lap.
2. Refrigerant piping and brine piping: Insulate with thickness per Section 230700-3.2, A. Thickness over 2-1/2 inch may be applied in two layers. Ends of inner layer sections shall be staggered and taped. End and longitudinal joints of outer layer shall be staggered with inner layer joints. Secure with 1-inch fiberglass filament tape 12 inches on center. Provide factory applied all service jacket on outer layer. Seal all ends of insulation runs.
3. Valves and Fittings: Pre-molded covers fabricated of same material and thickness as pipe insulation. Fill gaps with injected foam insulation. Secure covers with 1 inch fiberglass filament tape.
4. Vessels: Insulate with two layers of prefabricated curved segments to fit vessel. Stagger all joints. Secure with banding 18 inches on center. Extend side insulation past tank head to thickness of insulation, insert circular end insulation. Fill voids with injected foam insulation.
5. Brine pumps: Pumps shall be insulated with 2-inch total thickness of flexible expanded elastomeric insulation, install to allow for maintenance access to pump.

G. Air Distribution System:

1. Exterior surfaces of outside air, combustion air, mixed air, and recovery coil discharge:

One and one-half inch thick fiberglass three pound board with all service jacket. Seal all joints and pins with tape material to match jacket. Apply material with weld pins or stick clips.
2. Exterior surfaces of supply and return air plenums where not indicated to be lined:

One and one-half inch thick fiberglass three pound board with all service jacket. Seal all joints and pins with tape material to match jacket. Apply material with weld pins.
3. Exterior surfaces of exposed supply ductwork not lined:

One and one-half inch thick fiberglass three pound board with all service jacket. Seal all joints and pins with tape material to match jacket. Apply material with weld pins or stick clips.
4. Concealed supply ductwork not lined:

Two inch thick 0.75 pound fiberglass duct wrap with foil scrim facings. All joints sealed. Apply material with adhesive or wire 18 inches o.c.

5. Low pressure round runouts to diffusers:

Two inch thick 0.75 pound fiberglass duct wrap with foil scrim facings. All joints sealed. Apply material with adhesive or wire 18 inches o.c.
6. See Specification Section 230540 – Mechanical Sound and Vibration Control for requirements for lined ductwork.

H. Other Systems:

1. Piping Exposed to Freezing with Heat Trace:

One-inch thick fiberglass pipe covering with all service jacket-self seal lap. Finish with 0.016-inch thick corrugated aluminum jacket and fitting covers for protection.

NOTE: Insulation shall be applied over heat trace.
2. Piping Insulation Exposed to Rainfall:

Provide 0.016-inch thick corrugated aluminum jacket and fitting covers on all insulation exposed to rainfall. Install seam on bottom of horizontal and angled piping. Seal all joints weather-tight. Seal jacket seams with silicone sealant.
3. Protective Insulation Jacketing:

Provide high impact polyvinyl chloride pipe covering on insulated piping. Thickness to be 30 mil. Install where noted on drawings and per manufacturer's recommendations for hot and cold piping systems. Seal using solvent welding adhesive, providing slip joints as required for expansion and contraction. Ceel-Co Ceel-Tite 300 series, Schuller Zeston 300 series, or approved equal.
4. Condensate Drains Inside Buildings:

1/2" thickness fiberglass pipe covering with all service jacket self-seal lap.

END OF SECTION 230700

**SECTION 230810
VARIABLE FREQUENCY DRIVE**

PART 1 GENERAL

1.1 WORK INCLUDED

- A. The contractor shall furnish and install a complete Variable Frequency Drive and Energy Efficient motor system on the following equipment as described in this specification and as indicated on the drawings.
 - 1. Chilled water pumps
 - 2. Boiler pumps
 - 3. Secondary heating water pumps
- B. The Variable Frequency Drive shall convert 480 volt, three phase, 60 Hz utility power to adjustable voltage and frequency, three phase, A-C power for stepless motor control from 6 to 60 Hz.
- C. This contractor shall coordinate motor selection with Variable Frequency Drive.
- D. Variable Frequency Drive Systems shall be compatible with any standard NEMA B or C design 3-phase induction motor. Variable Frequency Drive Systems shall be sized to insure the motor full load amps does not exceed the controller continuous RMS amps at project altitude (4500 ft.).
- E. The VFD shall be interfaced to the building control system as specified in Section 230900.

1.2 QUALITY ASSURANCE

- A. The equipment supplied under this specification shall conform to the latest applicable codes and standards of the following:
 - 1. NEC – (NFPA 70) – National Electric Code.
 - 2. ANSI/NEMA ICS 6 – Enclosures for Industrial Controls and Systems.
 - 3. NEMA AB1 – Molded Case Circuit Breakers.
 - 4. NEMA ICS 2 – Industrial Control Devices, Controllers, and Assemblies.
 - 5. IEEE Standard 519-1992 – Recommended Practices for Harmonic Control in Electrical Power Systems.
 - 6. ANSI C37 – Standards for Circuit Breakers, Switchgear, Relays, Substations and Fuses.
 - 7. ANSI C57 – Distribution, Power, and Regulating Transformers (includes Reactors).
 - 8. UL 508C – Power Conversion Equipment.
 - 9. NEMA ICS 3.1 – Safety Standards for Construction and Guide for Selection, Installation, and Operation of Variable Frequency Drive Systems.
 - 10. FCC CFR 47 Part 15 subpart B.
- B. The VFDs shall be UL listed for conformance to UL-508C. An equivalent safety labeling program by ETL or CSA documenting compliance with these industry standards will be acceptable.

- C. The Division 23 Contractor shall coordinate and assume system responsibility and compatibility between the various approved suppliers' equipment and services required to meet these specifications.
- D. The VFD system vendor shall provide a complete parts and labor warranty (including travel and shipping expenses) for one (1) year from the date of substantial completion. The warranty shall cover the entire VFD system including power devices, controllers, harmonics, mitigation devices, communications interface, etc. furnished as part of the system package.
- E. The mechanical contractor shall coordinate the mounting location of the VFD with the electrical contractor to be certain that it is not mounted in the airstream of unfiltered exhaust air; i.e. in a parking garage application.

1.3 SUBMITTALS

- A. Shop Drawings: Submit shop drawings and product data in accordance with Section 230500 – Basic Mechanical Requirements.
 - 1. VFD: Product data sheets, functional descriptions, performance ratings, dimensions, conduit entry/exit locations, installation instructions, complete wiring diagrams for power, controls, etc.
 - 2. Control System Interface: Furnish complete documentation of the controls system interface including bus specification, object list, wiring diagrams, XIF or configuration files, etc.
 - 3. Derate calculation for installation altitude above 3300 ft. and ambient temperature above 40°C.
- B. Operating Instructions and Maintenance Data: Submit printed operating instructions and maintenance data in accordance with Section 230500 – Basic Mechanical Requirements.
 - 1. VFD: Operating and Maintenance instructions, programming instructions, spare parts lists, troubleshooting instructions.
 - 2. Factory test reports.
 - 3. Start-up and commissioning reports.
 - 4. Power quality and harmonic test reports.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. The following manufacturers are acceptable, submit alternates for prior approval in accordance with the General Conditions and Division 1 Requirements.
 - 1. ABB
 - 2. Yaskawa
 - 3. Graham/Danfoss
 - 4. Mitsubishi
 - 5. Grundfos Inc.
 - 6. Toshiba

2.2 CONSTRUCTION, VARIABLE FREQUENCY DRIVE

- A. The Variable Frequency Inverter(s) shall be PWM type using IGBTs, rated for the motor type, horsepower, and voltage as indicated on drawings.
- B. The Inverter shall be altitude compensated and sized for the elevation at which the unit will be installed. The inverter shall operate in an ambient temperature of -10°C to 50°C humidity of 0-90% non-condensing.
- C. The VFD system manufacturer shall integrate all components and equipment required to meet these specification features and functions as a single UL (or equivalent) labeled system. Vendors providing equipment requiring panel shop or job site modifications or additions that would not be valid under the original equipment manufacturer's (OEM's) safety labeling will not be acceptable.
- D. Pre-integrated equipment shall include but not be limited to incoming line filters, rectifier units, inverter units, control circuitry, operator interfaces, protective equipment, and other accessories and auxiliary items necessary to meet the highest standards for the type of service specified herein.
- E. All VFD system components shall be housed in a grounded, dead front, free-standing or wall mounted, NEMA 1 enclosure. The VFD system size shall not exceed the size allotments specified on the drawings nor shall any portion of the system exceed a height of 90 inches. Entry shall be provided for incoming line and load cables as required or as shown on the drawings.
- F. VFD systems mounted indoors shall be properly ventilated and sized to operate continuously at the job site elevation in an ambient environment of 0°C to 40°C , 0-90% RH. VFD systems mounted outdoors shall include environment control provisions as required (or as shown on the plans) to operate in an ambient of -30°C to 50°C , 0-100% RH.
- G. All components of the VFD system shall be selected to operate continuously without any system trip or damage based on the nominal power specifications and requirements shown on the drawings or schedules. The above conditions must be maintained under the following expected variations:
 - 1. Plus or minus 10% voltage fluctuation.
 - 2. Plus or minus 3% frequency variation (5% if served by a back-up generator).
 - 3. Distorted voltage waveform with up to 7% total voltage harmonic distortion.
- H. The VFD system shall employ voltage sag ride-through coordination under normal operating (average load) conditions to prevent nuisance trips with the following utility interruptions:
 - 1. 0% voltage for 1 cycle.
 - 2. 60% voltage for 10 cycles.
 - 3. 87% voltage continuous.

- I. The VFD system shall employ door mounted industrial control operator devices, programming unit, and other devices as required to meet all functional and feature requirements of this specification. Operator pilot lights or LEDs, switches and pushbuttons (if required) shall be industrial oil tight industry standard devices.
- J. Control voltages shall be 120 volts or less supplied by machine tool type transformers employing both primary and secondary fusing.
- K. The VFD system factory wiring shall be permanently marked with hot emboss stamping or an equivalent marking system. All devices shall be labeled and identified with correct setting selections. All component identification and wiring shall be documented in the operation and maintenance manual.
- L. The VFD system shall be capable of starting and continuously driving the specified maximum motor load as identified on the drawings and schedules.
- M. VFD's driving variable torque loads shall be programmed to optimize load patterns which maximize system efficiency and minimize motor heating and stresses. VFD's driving constant torque or other loads shall be programmed to optimize load patterns for system or process performance as required.
- N. All VFD systems shall have an overload capacity of a minimum of 120% for one minute.
- O. The VFD solid state converter and inverter power switching components and control shall be selected to achieve a 0.95 efficiency or better at full load and speed. Other auxiliary devices required on the drawings or in these specifications including filters, line reactors, cooling or heating devices etc. shall be of a design to optimize efficiency as intended under this specification.
- P. The entire true system power factor (as measured at the input to the VFD system) shall be 0.95 or better across the operational speed and load range. Power factor that becomes leading under light load conditions (due to PF correction) is acceptable only if voltage rise is prevented from backfeeding to the rest of the system (meaning PF correction must act like a synchronous condenser). The voltage tolerance at the main VFD system input terminals shall not be compromised as a result of power factor correction techniques.
- Q. Short circuit protection shall be provided to the VFD system through an externally operated, door interlocked fused disconnect, circuit breaker or motor circuit protector (MCP). VFD shall have a minimum short circuit rating of 65,00 amps RMS (100,000 amps RMS with DC bus reactor) without additional input fusing. The door interlocked handle must be capable of being locked off to meet NEC.
- R. Overcurrent protection shall be provided in the VFD system through electronic motor overload (MOL) circuits with instantaneous trip, inverse time trip, and current limit functions. These shall be adjustable and optimized for the application.

- S. In addition to the overcurrent protection above, the VFD system shall provide over and under voltage protection, over temperature protection, ground fault protection, and control or microprocessor fault protection. These protective circuits shall cause an orderly shutdown of the VFD, provide indication of the fault condition, and require a manual reset (except undervoltage) before restart. Undervoltage from a power loss shall be set to automatically restart after return to normal. The history of the previous three faults shall remain in memory for future review.
- T. The VFD system customer terminations shall be clearly identified with terminal numbers and a permanent wiring diagram located in the VFD system enclosure. Coordinate all control work with Section 230900 Contractor.
- U. VFD shall meet the requirements for Radio Frequency Interference as specified by FCC Regulations, Part 15, Subpart J, Class A devices.

2.3 FEATURES, VARIABLE FREQUENCY DRIVES

- A. The following operator control and indication features shall be provided standard (unless shown differently on the drawings) as part of each VFD system:
 - 1. Hand-Off-Auto (local start at VFD, remote start with contact closure).
 - 2. Local-Remote speed control (local speed control at VFD, remote speed control through speed reference signal).
 - 3. Frequency (speed) indication.
 - 4. Motor voltage indication.
 - 5. Motor current indication.
 - 6. VFD run indication.
 - 7. VFD fault and diagnostic indication.
- B. The following customer connections and interface terminations shall be provided standard (unless shown differently on the drawings) as part of each VFD system:
 - 1. VFD remote start/stop connection.
 - 2. External safeties connection.
 - 3. VFD run annunciation.
 - 4. VFD fault annunciation.
 - 5. VFD speed reference input connection (4-20mA or as shown on drawings).
 - 6. Minimum of three (3) programmable digital inputs.
 - 7. Minimum of two (2) 4-20mA input signals to integral controller.
- C. The following parameter adjustments shall be available to tune the VFD system:
 - 1. Minimum and maximum speeds.
 - 2. Acceleration and deceleration times.
 - 3. Overcurrent trip point.
 - 4. Current limit response to overload.
 - 5. Maximum base motor voltage.
 - 6. Input speed reference signal gain and bias.
 - 7. Output speed reference signal gain and bias.
 - 8. Critical frequency avoidance.
 - 9. Multiple preset speed programming.
 - 10. Integral PI controller programming.

- D. The VFD shall be capable of starting into a rotating motor at any speed and rotation direction.
- E. The VFD shall auto restart after a power failure.
- F. For maintenance purposes, the VFD system shall be capable of starting, stopping, and running with stable operation with the motor completely disconnected (no load).
- G. VFD shall include an integral locking disconnect.
- H. VFD shall include an integral PI controller capable of closed loop control of motor speed based on external analog speed reference signals or programmed digital input signals.
- I. VFD shall include an integral bypass motor starter. Include motor thermal overload and circuit breaker protection for bypass operation, and door-mounted selector switch. Bypass switch shall allow auto transfer to bypass on drive fault, remote transfer to bypass via contact closure, and selectable smoke purge function. Installation shall allow service or removal of VFD with bypass control left in place.

2.4 FACTORY TEST, VARIABLE FREQUENCY DRIVE

- A. Prior to shipping any equipment, the manufacturer shall individually test and certify each unit to document compliance. This certification report shall be submitted as part of the operation and maintenance manual and include the following minimum testing:
 - 1. A visual inspection shall be made consisting of all system components, wiring connections, and safety mechanisms.
 - 2. High pot testing shall be conducted on the completed VFD system including all accessory power components as a complete package. This test shall be conducted per UL 508C (two times the rated voltage plus 1000 volts AC for 60 seconds) using regularly calibrated high pot test equipment.
 - 3. A system run test shall be conducted using an actual motor accelerated and decelerated through the entire speed range.
 - 4. All control panel devices, including switches, pilot lamps, keypad and special control devices shall be functional tested.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Field start-up service shall be provided by an authorized factory representative. The supplier shall provide warranty and authorized factory services including field start-up and training. The following adjustments and tests shall be performed as a minimum with certified copies included in the operation and maintenance 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 this specification. Measurements shall be recorded for each unit with the VFD system off, running at 50% speed, and running at full speed and load.
- B. Owner training shall be provided for each model and type of VFD system provided. Training shall consist of both classroom and actual equipment hands-on training.
 - C. Installation shall be in accordance with manufacturer's printed instructions.
 - D. The mechanical contractor shall coordinate the mounting location of the VFD with the electrical contractor to be certain that it is not mounted in the airstream of unfiltered exhaust air; i.e. in a parking garage application. If no location is feasible to meet this location criteria, the VFD may be mounted inside a NEMA 3R enclosure in the dirty air location.

3.2 SPARE PARTS

- A. Furnish one spare main logic board, key pad, and power supply board. Furnish one set of spare parts for each unique VFD design supplied.

END OF SECTION 230810

**SECTION 230900
ELECTRONIC CONTROLS**

PART 1 GENERAL

1.1 RELATED WORK

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.
- B. Related work specified in other Sections:
 - Section 230500 - Basic Mechanical Requirements
 - Section 230529 - Basic Mechanical Materials and Methods
 - Section 230540 - Mechanical Sound and Vibration Control
 - Section 230593 - Testing, Adjusting and Balancing
 - Section 230700 - Mechanical Insulation
 - Section 232113 - HVAC Piping & Specialties
 - Section 232123 - HVAC Pumps
 - Section 233300 - Ductwork and Accessories
 - Section 233400 - Air Handling Fans
 - Section 235216 – Condensing Boilers
 - Section 236400 - Refrigeration

1.2 SYSTEM DESCRIPTION

- A. The work includes but is not limited to the following:
 - 1. The automatic temperature control system shall be electronic analog, digital or a combination of both and comprised of controllers that are stand-alone. PID (Proportional Integral, Derivative) control algorithms shall be applied on all temperature and pressure applications as called for hereinafter in the control sequences.
 - 2. The system shall include all control devices, valves and automatic dampers, wire, conduit, etc., as specified and required and connected so as to perform all functions and operate according to the specified sequences.

1.3 QUALITY ASSURANCE

- A. Manufacturing and Installation Qualifications:
 - 1. The Controls Subcontractor firm executing the work of this section shall have 3 years experience in work of similar scope and nature to that specified.
- B. This work includes all material, equipment and appurtenant accessories necessary for or incidental to the installation of a complete solid-state electromagnetic system of Automatic Temperature Controls.
- C. Controls to match existing control system.

1.4 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings and manufacturer's data for the following items in accordance with the General Conditions of the Contract:
1. Sensors
 2. PID Controllers
 3. Automatic control valves, schedule and wiring.
 4. Thermostats
 5. Thermometers
 6. Gauges
 7. Control diagrams
 8. Wiring diagrams
 9. Control panels
- B. Operating Instructions and Maintenance Data: Submit printed Operating Instructions and Maintenance Data for the following items in accordance with Operating and Maintenance Data paragraph in Section 230500.
1. Controls and instrumentation.
- C. Certificate: ATC Contractor shall submit a letter certifying completion of the control system in accordance with the Contract Documents.

PART 2 PRODUCTS

2.1 SENSORS & SWITCHES

- A. Temperature sensors shall be of the thermistor (NTC) type with a high resistance change versus temperature change to insure good resolution and accuracy. Sensors shall be available for room, duct or well mounting. Sensors shall connect to remote controller by means of a two-wire unshielded cable. Room type sensors shall be available with built-in setpoint potentiometer. Sensors shall be available in various ranges to properly suit the application.
- B. Humidity sensors shall be of the solid state type utilizing hygroscopic plastic as the sensing element. The sensor shall vary the output voltage with a change in relative humidity. Sensors shall be available for room or duct mounting. Sensors shall connect to remote controllers by means of a three-wire unshielded cable. Room type sensor shall be available with built-in setpoint potentiometer.
- C. Combination temperature and humidity sensor shall have thermistor (NTC) and hygroscopic plastic elements mounted in a common enclosure. Sensor shall connect to remote controller by means of a four-wire unshielded cable. Room type sensor shall be available with built-in setpoint potentiometers for both temperature and humidity.
- D. Industrial temperature sensors shall be platinum (PTC) with high repeatability and accurate to +0.5°F. Sensor shall be suitable for room, duct or well mounting. Sensor shall be suitable for various ranges by selecting the appropriate range cards. Sensor shall connect to controller by means of a three-wire unshielded cable.

- E. Zone dampening sensor element shall be suitable for duct mounting and capable of dampening an individual zone sensor by electronically paralleling the zone sensor's signal. Sensor shall connect to controller by means of a two-wire unshielded cable. Sensor shall be of the thermistor (NTC) type.
- F. Strap-on type sensor shall vary its resistance over its entire range of sensed water temperature from 50°F to 230°F in a pipe 3/4" to 2-1/2" in diameter without requiring immersion or well mounting. Sensor shall connect to controller by means of a two-wire unshielded cable. Sensor shall be of the thermistor (NTC) type.
- G. Duct-mounted averaging type temperature sensor shall utilize a nickel resistance sensing element incorporated in a copper capillary of 27 feet. The sensor shall vary the output voltage with a change in temperature. Sensor shall connect to the remote controller by means of a three-wire unshielded cable.
- H. Differential pressure sensor shall vary the output voltage with a change in differential pressure. The sensor shall connect to the remote controller by means of a three-wire unshielded cable.
- I. Window surface temperature sensor shall mount to inside of window with adhesive strips assuring good surface contact and accurate glass temperature transmission while being unaffected by surrounding air temperature. Sensor shall vary resistance with a change in window temperature and connect to controller by means of a two-wire unshielded cable. Sensor shall be of the thermistor (NTC) type.
- J. Duct-mounted industrial humidity sensor shall utilize cold electrodes for sensing relative humidity from 0 - 100%. Accuracy shall be $\pm 2\%$ from 10 - 80% and $\pm 4\%$ from 0 - 20% and 80 - 100% RH. The sensor shall be a four-wire device and connect to controller by means of a four-wire unshielded cable. Sensor shall be available with integral PTC industrial platinum temperature sensor shall change its output voltage with change in sensed humidity.
- K. Absolute humidity (Dewpoint) sensor shall utilize a lithium chloride element to sense the actual quantity of water per volume of dry air when the relative humidity is from 12% to 100%. The sensor shall be highly repeatable at a given temperature and change its output resistance with a change of water content in the air. The four-wire sensor shall connect to the controller by means of a four-wire unshielded cable.
- L. Air velocity sensor shall be capable of linear indication of the velocity of air in a duct from 0 to 3000 FPM, and shall vary its output voltage with a change in air velocity. The sensor shall connect to the controller by means of a four-wire unshielded cable.
- M. Outdoor air sensor shall be of the thermistor (NTC) type with a high resistance change versus temperature change. Sensor shall be available for outdoor or duct mounting. Sensor shall connect to remote controller by means of a two-wire unshielded cable. Outdoor type sensor shall be available with integral wind sensor which changes its output voltage with a change in wind velocity. Combination sensor shall connect to controller by means of five-wire unshielded cable.
- N. Contamination sensor shall vary the conductivity as the degree of gas or smoke concentration changes. The sensor shall connect to the remote control by means of a three-wire unshielded cable.

- O. Solar sensor shall be designed to mount on the interior side of a window pane reference room. The side facing the sun shall be coated with a dull black lacquer to transform the incoming solar energy into heat. The temperature of the measuring plate shall represent an exact value of the radiation influence and shall not be affected by the ambient temperature in the reference room. The sensor shall connect to the remote controller by means of a two-wire unshielded cable.
- P. Duct sensor/adaptor shall be of the thermistor (NTC) type and suitable for mounting directly to the back of the integral sensor/controller making it capable of duct temperature sensing as a single unit.
- Q. Carbon Monoxide and Nitrogen Dioxide Sensors/Transmitters:
 - 1. Fully addressable, the gas transmitter must be capable of transmitting gas concentrations digitally to the control system, and shall be capable of sending an analog 4-20mA signal to the building control system. The gas transmitters must be installed in a true daisy chain with an end of line resistor on the last transmitter. Capable of remote sensing at distances of up to 300 feet, the gas transmitter will incorporate an electrochemical cell. The unit's sensing cell must compensate for variations in relative humidity and temperature to maintain high levels of accuracy, capable of operating within relative humidity ranges of 5-90% and temperature ranges of 0°F to 110°F (-18°C to 43°C).
 - 2. A 10-step LED display (with the possibility of adding to optional LCD) will provide gas concentration readings. A green LED will indicate normal operation and a yellow LED will indicate fault operation. The transmitter must also be capable of incorporating an audible alarm (rated at no less than 65Db at a distance of 3 feet), which will be activated at fully programmable levels through an associated control panel. The unit will be manufactured to UL 1244 label and CSA 22.2. Provided any necessary control panels from same manufacturer.
 - 3. Manufacturer/Model: Vulcain 201T CO and 201T NO2.
- R. Carbon Dioxide (CO₂) Sensors/Transmitters shall be a 3-wire device that measures carbon dioxide content in the surrounding environment and reports a 0-2000ppm content with a corresponding 0-10VDC output reading. Veris #CWE or approved equal.

2.2 ACCEPTABLE MANUFACTURERS

- A. Match existing control system

2.3 FACILITY MANAGEMENT CONTROL SYSTEM (FMCS)

- A. The Facility Management Control System (FMCS) shall be comprised of a network of interoperable, stand-alone digital controllers. The FMCS shall incorporate Backnet technology using Free Topology Transceivers (FTT-10), or Ethernet in all unitary, terminal and other device controllers. The system shall include:
 - 1. Programmable Equipment Controllers (PEC's) for control of primary mechanical systems and distributed system applications. Controllers shall be fully programmable to create custom control solutions.
- B. Network Area Controllers (NAC's) for distributed system applications, databases and networking functions.

- C. Application Specific Controllers (ASC's) for control of VAV terminal units, Fan coil terminal units, Unit Vent terminal units, Heat Pump units and other terminal equipment.
- D. Graphical User Interface (GUI), which includes the hardware and software necessary for a user to interface with the control system and devices.
- E. The PEC and ASC network shall communicate at a minimum 78Kbps using Backnet. The GUI and NAC shall reside on a Ethernet backbone.
- F. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices.

2.4 NETWORK AREA CONTROLLER (NAC)

- A. The Network Area Controller (NAC) shall provide the interface between the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
 - 1. Calendar functions
 - 2. Scheduling
 - 3. Trending
 - 4. Alarm monitoring and routing
 - 5. Time synchronization
 - 6. Integration of BACnet and MODBUS networks
- B. The NAC shall provide multiple, concurrent user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.
- C. The NAC shall support standard Web browser access via the Intranet/Internet. It shall be capable of supporting multiple users, expandable to fifty.
- D. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 - 1. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.
 - 2. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
 - a. To alarm
 - b. Return to normal
 - c. To fault
 - 3. Provide for the creation of an unlimited number of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
 - 4. Provide timed (schedule) routing of alarms by class, object, group, or node.
 - 5. Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
- E. Alarms shall be annunciated in any of the following manners as user defined:
 - 1. Screen message text.

2. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
 - a. Day of week
 - b. Time of day
 - c. Recipient
 3. Pagers via paging services that initiate a page on receipt of email message
 4. Graphic with flashing alarm object(s)
 5. Printed message, routed directly to a dedicated alarm printer
 6. Cell phones
- F. The following shall be recorded by the NAC for each alarm (at a minimum):
1. Time and date
 2. Location (building, floor, zone, office number, etc.)
 3. Equipment (air handler #, accessway, etc.)
 4. Acknowledge time, date, and user who issued acknowledgement.
- G. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
- H. A log of all alarms shall be maintained by the NAC and/or a server and shall be available for review by the user.
- I. Provide a "query" feature to allow review of specific alarms by user defined parameters.
- J. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
- K. An Error Log to record system errors shall be provided and available for review by the user.
- L. Data Collection and Storage
1. The NAC shall collect data for any property of any object and store this data for future use.
 2. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:
 - a. Designating the log as interval or deviation.
 - b. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 - c. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - d. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 - e. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
 3. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a standard Web Browser.
 4. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.

5. All log data shall be available to the user in the following data formats:
 - a. HTML
 - b. XML
 - c. Plain Text
 - d. Comma or tab separated values
 6. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties, at a minimum:
 - a. Archive on time of day
 - b. Archive on user-defined number of data stores in the buffer (size)
 - c. Archive when buffer has reached its user-defined capacity
- M. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:
1. Time and date
 2. User ID
 3. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
- N. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time of day.
1. Copies of the current database and, at the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.
 2. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.5 PROGRAMMABLE EQUIPMENT CONTROLLERS (PEC)

- A. Programmable Equipment Controllers (PEC's) shall be stand-alone, multi-tasking, real-time digital control processors.
- B. The PEC's shall communicate via Backnet.
- C. The PEC must communicate peer-to-peer with all of the network application specific, programmable controllers.
- D. The PEC software database must be able to execute all of the specified mechanical system controls functions. The programming software shall be able to bundle software logic to simplify control sequencing. All values, which make up the PID output value, shall be readable and modifiable at a workstation or portable service tool. Each input, output, or calculation result shall be capable of being shared/bound with any controller or interface device on the network.
- E. Provide programming, engineering, and configuration tools used for the project duly licensed to the owner for owner's use.

- F. PEC's shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
- G. A single process shall be able to incorporate measured or calculated data from any and all other PEC's on the network. In addition, a single process shall be able to issue commands to points in any and all other PEC's on the network.
- H. Each PEC shall support firmware upgrades without the need to replace hardware.
- I. Each PEC shall continuously perform self-diagnostics, which include communication diagnosis and diagnosis of all components.
- J. In the event of the loss of normal power, there shall be an orderly shutdown of all PEC's to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
 - 1. Upon restoration of normal power, the PEC shall automatically resume full operation without manual intervention.
 - 2. All PEC's control programming and databases must be stored in Flash memory, therefore eliminating data loss, downtime and re-load time.
- K. Provide a separate PEC for each AHU or other HVAC system such that the inputs, calculations, and outputs shall reside on a single controller.

2.6 APPLICATION SPECIFIC CONTROLLERS (ASC)

- A. Each Application Specific Controller (ASC) shall operate as a stand-alone Backnet controller capable of performing its specified control responsibilities independent of other controllers in the network. Each ASC shall be a minimum 16-BIT microprocessor based, multi-tasking, multi-user, real time digital control processor.
- B. Controllers shall include all inputs and outputs necessary to perform the specified control sequences. Analog and digital outputs shall be industry standard signals such as 0-10V and 3-point floating control allowing for interface to a variety of industry standard modulating actuators. The ASC inputs and outputs shall consist of industry standards types. Inputs shall be electrically isolated from outputs, communications and power.
- C. All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over the network is not acceptable.
- D. The control program shall reside in the ASC. The application program and the configuration information shall be stored in non-volatile memory with no battery back-up required.
- E. After a power failure the ASC must run the control application using the current setpoints and configuration. Reverting to default or factory setpoints are not acceptable.

2.7 GRAPHICAL USER INTERFACE SOFTWARE (GUI)

- A. Command of points from multiple manufacturers shall be transparent to the operator.

- B. The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. The GUI software shall run on a Windows XP 32-bit operating system. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line FMCS alarms and monitoring information. If the software is unable to display several different types of displays at the same time, the FMCS contractor shall provide at least two operator workstations at each location specified.
- C. Real-Time Displays. The Graphical User Interface (GUI), shall at a minimum, support the following graphical features and functions:
1. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures and streaming video.
 2. Provide programming, engineering, and configuration tools used for the project duly licensed to the owner for owner's use.
 3. A gallery of HVAC and automation symbols shall be provided, including fans, valves, motors, chillers, AHU systems, standard ductwork diagrams and symbols. The user shall have the ability to add custom symbols to the gallery as required.
 4. Graphic screens shall contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
 5. Graphics shall include layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.
 6. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
 - a. Schedule times will be easily adjustable by the operator.
 - b. Holidays shall be set by mouse command using a graphical calendar.
 7. Commands to start and stop binary objects shall be done by mouse command from the pop-up menu.
- D. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:
1. Create, delete or modify control strategies, alarms, and schedules.
 2. Add/delete objects to the system.
 3. Tune control loops through the adjustment of control loop parameters.
 4. Enable or disable control strategies.
 5. Generate hard copy records or control strategies on a printer.
 6. Select points to be alarmable and define the alarm state.
 7. Select points to be trended over a period of time and initiate the recording of values automatically.

- E. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.
- F. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.
- G. All graphic displays shall be provided using web browser client as specified in 2.11.
- H. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
- I. When the Alarm Console is enabled, a separate alarm notification window will supercede all other windows on the desktop. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable. The alarm console shall be loaded and operated at the following locations.

2.8 WEB BROWSER CLIENTS

- A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer® or Chrome® or FireFox®. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
- B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Web page access and control shall be from system Network Area Controllers, or the Workstation.
- C. The Web browser shall provide the same system view, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
- D. The Web browser client shall support at a minimum, the following functions:
 - 1. User log-on identification and password security shall be required and implemented using Java authentication and encryption techniques to prevent unauthorized access. If an unauthorized user attempts access, a blank web page shall be displayed.
 - 2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.

3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
4. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client machine are not acceptable.
5. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - a. Modify in a graphical manner, common application objects, such as schedules, calendars, and set points. Schedule times will be adjusted by mouse command using a graphical slider, or requiring any keyboard entry from the operator. Holidays shall be set by mouse command using a graphical calendar, or requiring any keyboard entry from the operator.
 - b. Commands to start and stop binary objects shall be done by mouse command right-click of the selected object and selecting the appropriate command from the pop-up menu.
 - c. View logs and charts
 - d. View and acknowledge alarms
7. The system shall provide the capability to specify a user's home page (as determined by the log-on user identification). From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.9 PROJECT SPECIFIC WEB PAGES

- A. Home page shall include a campus layout of the individual buildings at the site. Once an individual building is selected the following minimum web-based tree structure shall be provided. All graphics shall be submitted with the controls submittal package.
 1. Documents Page: The document page shall include the O&M Manuals for the control system in PDF format along with AutoCAD drawings for each drawing provided in the control system O&M Manual. This document page shall include links between the control diagrams and associated data sheet in PDF format, such that the system user shall be able to click on the control device and retrieve, in PDF format, the factory O&M sheets associated with that device.

2. Station Functions:
 - a. Any data point shall be trend-able with the option of adjusting the sampling frequency in days, hours, minutes, and seconds or by change of value. Trended data points shall be viewable in a graphical format that allows for selecting up to six trended data points to be viewed against one another simultaneously. Graphical trend log viewing shall provide for independent manual vertical and horizontal range adjustment. Trend logs shall be downloadable in a comma separate numerical values format.
 - b. The alarm acknowledgement via the web shall allow the viewing and acknowledgement of the alarms.
 - c. Audit log shall be provided via the web to show the operator actions as well as other audit logs as specified in section 2.4 Network Area Controller (NAC) paragraph "M" Data Collection and Storage.

3. Floor Plans:
 - a. AutoCAD drawings of floor plans shall be provided in the control system such that via the web the user shall be able to turn layers on and off on the mechanical floor plans. These floor plans shall also include an overlay of the temperature control as-built wiring for the project showing thermostat locations, communication runs, transformer locations, controller locations, etc.
 - b. Floor Display Summaries. The operator shall be able to select floor plans displaying the following formats:
 - 1) All zone temperatures
 - 2) All zone heating percentages
 - 3) All zone cooling percentages
 - 4) All zone room names and numbers
 - 5) All zones cfm delivered.

4. Upon selecting a graphical floor plan layout the web page shall show all the zone temperature sensor locations on the floor. By clicking on the zone temperature location, an individual VAV box graphic shall be displayed with the following attributes:
 - a. A manual menu that shall allow the operator to manually set the air flow set point, space temperature set point, damper position, cooling percentage, heating percentage, and zero the box.
 - b. A 24 hour log chart that shows space temperature history, flow history, and allows the operator to build custom charts by comparing this log to other associated selectable logs.
 - c. A display of the VAV box discharge temperature, air handler discharge temperature, space temperature, and space temperature set point.
 - d. The graphic shall display actual CFM, current air flow, and current air floor set point, percentage of heating and cooling changes and mode.
 - e. The damper position, reheat valve position, occupancy status, room name and heating/cooling mode shall also be shown.

B. Systems:

1. On selecting the systems menu, a tree structure shall allow the operator to select the air handlers, chillers, control valves, heat exchangers, med gas, etc. systems associated with that building. The graphics shall also show the piping and ductwork associated with the air handler as well as the safeties, temperature sensors, humidity sensors, dampers, VFD's, associated with that fan system. See points lists for specifics.
2. All devices that provide dynamic function in the primary equipment, i.e., fans, pumps, coils, dampers shall be dynamic in nature showing their operating status/percentage of capacity by movement on the web page.
3. The set points for the various control loops shall be adjustable via the web page. Individual controlled devices, i.e., valves, dampers, fans shall be controlled via the web page and be stopped or started or placed in a command state or percentage of value output.

2.10 FIELD DEVICES

A. Provide automatic control valves, automatic control dampers, thermostats, clocks, sensors, controllers, and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard control system components as indicated by published product information, designed and constructed as recommended by manufacturer.

B. Temperature Sensors:

1. Temperature Sensors: Temperature sensors shall be linear precision elements with ranges appropriate for each specific application.
2. Space (room) sensors shall be available with setpoint adjustment and override switch.
3. Duct mounted averaging sensors shall utilize a sensing element incorporated in a copper capillary with a minimum length of 20 feet. The sensor shall be installed according to manufacture recommendation and looped and fastened at a minimum of every 36 inches.
4. Sunshields shall be provided for outside air sensors.
5. Thermo-wells for all immersion sensors shall be stainless steel or brass as required for the application.

C. Humidity Sensors: Humidity sensors shall be of the solid-state type using a capacitance-sensing element. The sensor shall vary the output voltage with a change in relative humidity. Room humidity sensors shall have a minimum range of 10% to 90% \pm 5%. Supply air humidity sensors shall have a range of 10% to 90% \pm 5%.

D. Pressure Sensors: The differential pressure sensor shall be temperature compensated and shall vary the output voltage with a change in differential pressure. Sensing range shall be suitable for the application with linearity of 1.5% of full scale and offset of less than 1% of full scale. Sensor shall be capable of withstanding up to 150% of rated pressure without damage.

E. Flat plate (flush mount) temperature sensors shall be installed as directed by architect in public corridors, behavior health and any other locations where gurneys and/or carts could damage sensors and where public access of setpoint is not desired.

2.11 SWITCHES AND THERMOSTATS

- A. The FMCS Contractor shall furnish all electric relays and coordinate with the supplier of magnetic starters for auxiliary contact requirements. All electric control devices shall be of a type to meet current, voltage, and switching requirement of their particular application. Relays shall be provided with 24 VAC coils and contacts shall be rated at 10 amps minimum.
- B. Duct Smoke Detectors: Duct smoke detectors shall be supplied by others with an integral auxiliary contact to be used by the FMCS contractor to provide a digital input to the FMCS.
- C. Low Temperature Detection Thermostats: Shall be the manual reset type. The thermostat shall operate in response to the coldest one-foot length of the 20-foot sensing element, regardless of the temperatures at other parts of the element. The element shall be properly supported to cover the entire downstream side of the coil with a minimum of three loops. Separate thermostats shall be provided for each 25 square feet of coil face area or fraction thereof.
- D. Differential Pressure Switches: Pressure differential switches shall have SPDT changeover contact, switching at an adjustable differential pressure setpoint.
- E. Current Sensing Relays: Motor status indications, where shown on the plans, shall be provided via current sensing relays. The switch output contact shall be rated for 30 VDC, .15 amps.
- F. Flow Switches: Motor status indications, where shown on the plans, shall be provided via flow switches. Flow switches shall be of the paddle type equipped with SPDT contacts to establish proof of flow.
- G. Carbon Monoxide Detector and Controller shall meet or exceed UL 2034 standard and OSHA standards for CO exposure. Controller shall be solid state sensor. Fan relay shall activate at 35 ppm of CO averaged over 5 minutes. Alarm relay shall activate at 100 ppm after 30 minutes. Approved manufacturers shall be Macurco, Inc or approved equal.

2.12 TERMINAL EQUIPMENT CONTROLLERS (TEC)

- A. Terminal Equipment stats for all heat pumps and VAV boxes shall include a digital key pad and display with the following functionality.
 - 1. The stat shall provide visual indication of occupancy status, heating and cooling mode, space temperature, space temperature set point, and VAV box air flow or heat pump discharge air temperature. The operator shall be able to adjust space temperature set point and also change the zone mode from occupied to unoccupied.
 - 2. In the service mode or commissioning mode, on entry of the appropriate PIN number, the operator will be able to view and change heating dead band and cooling maximum volume setting as well as calibrate the flow sensor to actual CFM measuring for the balancing hood. The operator shall be able to command the controller to heating or cooling, i.e., the thermostat key pad functions as a commissioning/programming device.
- B. Device shall have a back-lit digital display.
- C. The com port on this stat shall allow the building engineer to access and command any point on the network using a lap top computer.

2.13 CONTROL VALVES

- A. 5" and 6" valves for heating and chilled water shall be flanged and two-way or three-way as required. Valve body shall be cast iron with chrome nickel steel seat and alloy inner valve. Rangeability shall be at least 50 to 1. Valve actuator shall be of the 3 point floating type or 0-10 VDC proportional type as necessary. Manual positioner shall be provided for hand operation of valve in the event of power failure.
- B. Drive and inner valve for use with humidifiers shall be of the modulating magnetic type with a rangeability of at least 50 to 1. Valve shall be available with choice of inner valve assemblies of different capacities to custom fit valve capping with steam quantity required. Inner valve shall be made of chrome nickel steel. Valve shall be of the spring return type and return to its normal position in the absence of control power. Valve shall have manual positioner for hand operation in the event of power failure.
- C. Drive and valve for low volume heating or chilled water shall be for the modulating type with two-way screwed fittings. Valve shall spring return to its normal position in the absence of control power. Valve body shall be nickel plated brass, seat shall be brass, and inner valve material shall be ethylenepropylene rubber.
- D. Valves for high temperature heating water and high pressure steam shall be of the two-way modulating magnetic type. Valve body shall be cast steel with flanged connections, inner valve shall be chrome nickel steel. Valve shall have manual positioner for hand operation in the event of power failure and shall spring return to its normal position in the absence of control power. Valve shall be available with stroke time dampening for applications requiring a stroke time of more than one second.
- E. Valves for use with domestic water shall be of the two-way or three-way type as required with a rangeability of at least 50 to 1. Valve body shall be red brass and have chrome nickel steel seat and inner valve and shall have union connections. Valves shall have manual positioner for hand operation of a valve in the event of power failure. Valve shall return to its normal position in the absence of control power, actuator shall be available with capability or use with low temperature mediums.
- F. Valves for control of high pressure halogen refrigerants shall be of the two-way or three-way modulating type. Valve body shall be of high pressure brass with solder connections and have a seat and inner valve of chrome nickel steel. The valve shall spring return to its normal position in the absence of control power.
- G. Valves for use with high temperature heating water and steam shall be of the two-way or three-way modulating type with a rangeability of at least 50 to 1. Valve body shall be cast iron with flanged connections, inner valve, seat and plug shall be of chrome nickel steel. Valve shall have manual positioner for hand operation in the event of power failure. Valve shall spring return to normal position in the absence of control power. Valve shall be available with stroke time dampening for applications requiring a valve stroke time of more than one second.

- H. Valves used for control of hot water and chilled water shall be of the modulating type with a rangeability of at least 50 to 1. Valve body shall be cast iron, seat and inner valve material shall be chrome nickel steel. Valve sizes 2" and smaller shall be screwed and supplied with union fittings. Valve 2-1/2" and larger shall be flanged. Valves shall be of the three-way or straight-thru type as required by the sequence or shown on the mechanical drawings. Valve shall be equipped with hand wheel to allow manual position of valve in the absence of control power. Valves shall be of the spring return type that will return to their normal position in the absence of control power.
- I. Valves used for fan coil or terminal reheat shall be of the modulating type with a rangeability of at least 50 to 1. Valve body and seat material shall be bronze. The inner valve and stem material shall be stainless steel. The valve shall be of the two-way or three-way type.

2.14 DAMPER ACTUATORS

- A. Actuators shall be of the push-pull or rotary type for either modulating or two-positioning control. Actuators shall stroke by a rotating motion of an overload-proof synchronous motor. Control voltage shall be either 24 VAC or 0-10 VDC as required by the application. Actuators shall be available with spring return to the fully extended position upon power failure. Three (3) point floating actuator shall be available with adjustable end switches. Minimum/maximum manual positioners shall be available for all motors.
- B. Mixing box actuators shall be of the rotary drive type as required, capable of permanent stall operation without damage. Rotary drive actuators shall have adjustable stop pins for stroke limit and shall fit directly over the damper shaft. Gears shall be nickel steel. Gears and bearings shall be oil impregnated for lifetime lubrication.
- C. High temperature cut-outs (HTCO) shall be designed to be mounted in the return air or exhaust duct system and wired to shutdown fans when air temperature rises above its setpoint. HTCO shall be of the manual reset type and supplied for all fans over 2000 CFM.
- D. Flow switches shall be of the paddle type equipped with SPDT contacts to establish proof of flow. Flow switches shall be of the vapor-proof type similar to McDonnell Miller FS8-V.
- E. Line voltage to 24 VAC transformer shall be supplied as required to provide adequate control voltage to control system.

2.15 OXYGEN MONITOR IN MACHINERY ROOM (FOR R-22 OR R-134a MACHINES)

- A. Acceptable Models:
 - 1. Delta F Corporation, Series 500
 - 2. INTEC Controls QCW-500
 - 3. Alternate sensors shall be approved prior to bid and meet the following criteria:
 - Sensor to be nondepleting coulometric or electro-chemical cell with a warranty of 5 years.
 - Monitor to be digital with 0-25% range and an accuracy of +/- 1% of full scale.
 - Response time to be 30 seconds for a 90% response. Monitor shall include two (2) fully adjustable setpoints, an instrument condition alarm relay, and an voltage or current output signal.

2.16 REFRIGERANT MONITOR IN MACHINERY ROOM (FOR R-123 MACHINES)

- A. Acceptable Models:
 - 1. General Analysis Corporation, LAN Ia, Yokogawa HGM300.
 - 2. Alternate sensors shall be approved prior to bid and meet the following criteria: Monitor shall have the capability of detecting, alarming and controlling from 0 - 50 ppm. Digital display accuracy shall be within 1 ppm. Monitor shall require only minimum maintenance: recuperations shall be no more than once every five years; and rezeroing shall be done no more than once every week. Monitor shall be capable of operation in ambient temperatures from 40 to 105 F. Outputs to include two analog and three binary with individual closure setpoints.

PART 3 EXECUTION

3.1 GENERAL

- A. Installation of the automatic control system shall be made and supervised by mechanics who are full time employees of the Controls Subcontractor.
- B. All installation work shall be scheduled and coordinated with other trades to expedite job progress.
- C. The installation shall match erection of slabs and walls such that no damage, cutting or patching will be required.
- D. All work shall be installed in accordance with current control industry practices.
- E. Only top quality workmanship will be permitted.
- F. Any work not properly executed shall be removed and replaced without extra expense to the Owner.

3.2 SENSORS AND GUARDS

- A. Temperature controls trades shall verify all wall mounted sensor locations with the General Contractor in order to avoid interference with wall mounted furnishings.
 - 1. Where interferences require moving the sensor more than two feet, consult with the Engineer for new location.

3.3 FREEZE PROTECTION THERMOSTATS

- A. Provide freeze stat as shown on drawings to stop the fan and close the outside damper upon sensing any one foot section below 40°F (adjustable).

3.4 ELECTRIC WIRING

- A. All control and interlock wiring shall be as specified in "Electric Wiring" paragraph in Section 230529 - Basic Mechanical Materials and Methods. Provide diagrams and coordinate all work with the Division 26 contractor as required.

3.5 SERVICE AND WARRANTY

- A. The control system herein specified shall be free from defects and workmanship and material under normal use and service. After completion of the installation the controls contractor shall regulate and adjust all thermostats, control valves, damper motors and other equipment provided under this contract. If within twelve (12) months from the date of completion any of the equipment herein described is proved to be defective in workmanship or materials, it will be replaced or repaired free of charge in accordance with "Warranties" paragraph in Section 230500.
- B. The controls contractor shall after completion, provide any service incidental to the proper performance of the control system under guarantees outlined in Division 1 for the period of one year.
- C. When all devices are installed, a fully qualified technician shall set, adjust and calibrate all components.
 - 1. A letter certifying completion of the system shall be forwarded to the Engineer's office, prior to acceptance of project by Owner.

3.6 INSTRUCTION AND ADJUSTMENT

- A. On completion of the job the controls contractor shall have completely adjusted the entire control system. He shall arrange to instruct the Owner's representative on operation of the control system and supply him with three (3) copies of the control operating and instruction manuals. He shall obtain from the owner's representative a signed receipt that he has received the instruction manuals and complete instructions on the operation of the system.
- B. Record Drawing: At completion of the job the controls contractor shall furnish two (2) copies of corrected wiring diagrams, one enclosed in laminated plastic and mounted on wall of the main mechanical room or as directed.
- C. Contractor Adjustments: At the completion of the job the controls contractor must submit to the Architect a letter stating that he has made final calibrations and adjustments to the system and that the owner's operating personnel have been instructed in its use.

3.7 SEQUENCE OF OPERATION

- A. See Drawings.

END OF SECTION 230900

**SECTION 231123
NATURAL GAS SYSTEM**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pipe and Fittings.
- B. Gas Meter.
- C. Gas Pressure Regulator.
- D. Flexible Connectors and Quick Couplers.

1.2 RELATED REQUIREMENTS

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.
- B. Section 230500 - Basic Mechanical Requirements.

1.3 RELATED SECTIONS

- A. Section 230529- Basic Mechanical Materials and Methods: Valves, pipe hangers, supports and accessories.
- B. Section 230548 - Mechanical Seismic Control.
- C. Section 224450 - Plumbing Equipment: Gas supply and runout with gas cock or valve to water heater connection points.
- D. Section 235216 – Condensing Boilers: Gas supply and runout with gas cock or valve to boiler connection points.

1.4 REFERENCES

- A. NFPA 54 (ANSI Z223.1) - National Fuel Gas Code.
- B. ANSI Z223.1a - Supplement to National Fuel Gas Code.

1.5 DEFINITIONS

- A. The following are references with definition acronyms used in this section:
 - 1. U.L. - Underwriters Laboratory Listed for Fire Protection Systems.
 - 2. F.M. - Factory Mutual Engineering Division.
 - 3. IRI - Industrial Risk Insurers AKA: F.I.A. Factory Insurance Association.
 - 4. Jurisdictional Agencies:
 - a. Building Department.
 - b. Fire Department or Fire Prevention Bureau or Marshal.
 - c. Insurance Agency, Carrier, and/or Underwriter.
 - d. Engineer refers to the consulting Mechanical Engineer of record.

1.6 SYSTEM DESCRIPTION

- A. Provide gas supply from gas meter outlet to all gas consuming equipment complete with piping, meters, valves, unions, dirt legs, hangers, supports, anchors, expansion compensators and regulators.

1.7 QUALITY ASSURANCE

- A. Welding: Welders shall be certified in accordance with requirements in Section 230529.

1.8 REGULATORY REQUIREMENTS

- A. Conform to Regulatory Requirements listed in Section 230500.
- B. Provide special inspections required in IBC Chapter 17.

1.9 SUBMITTALS

- A. Submit Product Data for the following items under provisions of the General Conditions of the Contract:
 - 1. Pipe, fittings, valves, hangers and supports.
 - 2. Gas solenoid valves, cabinets and controls.
 - 3. Regulators.
 - 4. Meters.
- B. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:
 - 1. Gas solenoid valves and controls.
 - 2. Regulators.
 - 3. Meters.
 - 4. Valves.
 - 5. Quick Couplers.
- C. Submit certified test reports, dated and signed by authorized person showing compliance of tests of the fuel gas systems, in accordance with the Contract Documents.

1.10 SEQUENCING/SCHEDULING

- A. Coordinate all work with all other trades and utility companies for elimination of interference, utilization of combined hanger support systems, timely routing and installation of systems, verifications of existing connector utilities, locations, depths, connection regulation, proper valving and junction structures or fittings. Location of meters, and remote readers as applicable and appropriate.

1.11 WARRANTIES

- A. Provide original copies of all warranties for specific equipment where specified and in accordance with Section 230500.
- B. Provide 20 year full warranty on all cathodic protection and pipe wrapping against corrosion of piping due to electrolytic or active soil conditions.

1.12 GAS SERVICE

- A. Arrange with Utility Company to provide gas service to indicated location with shut-off at terminus. Consult with Utility as to extent of its work, costs, fees and permits involved. 231123 Contractor shall pay such costs and fees; obtain permits.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

- A. Buried Exterior (meter and building service):
 - 1. Pipe: Schedule 40 Black Steel ASTM A-53 pipe for butt welding or plastic piping as defined below when acceptable jurisdictional authorities.
 - 2. Fittings: Butt weld steel, ASTM-234.
 - 3. Wrapping: Scotchwrap 10 mil PVC tape or Standard of serving Utility Company.
 - 4. Contractor's Options, when acceptable to jurisdictional authorities:
 - a. Natural Gas:
 - 1) High Density Polyethylene pipe and fittings; ASTM D-3350:335434C, PPI:PE 3408/3406, Type III, Grade P34 Category 5 per ASTM D 1248, SDR 11 pipe.
 - 2) Polyvinylchloride natural gas pipe and fittings:

Size 1/2" thru 1-1/2": Sch. 40 Type 1 PVC 1120, IAPMO: 15-10-71, ASTM D 1785.

Size 2" thru 6": Class 315 Type 1 PVC 1120, IAPMO: 15-10-71, ASTM D 2513.

B. Interior Exposed or Accessible:

1. Size 1/2" thru 1-1/2":

Pipe: Schedule 40, ASTM A 53

Fittings: Threaded malleable iron

Joint Seal: Teflon

Unions: Black malleable iron ground joint, bronze to iron seat, 150 lb. class, ANSI B2.1 and ASTM A 197.

2. Size 2" and over:

Pipe: Schedule 40, ASTM A53, Type S Grade B

Fittings: Butt weld ASTM A 234

Unions: 150 lb. forged steel weld neck flange, ANSI B16.5 and ASTM A105.

C. Interior, concealed, non-accessible spaces and return air plenums:

Use no unions, tubing fittings, right or left couplings, bushing, shut-off valves, compression coupling, or swing joints made by combinations of fittings.

2.2 GAS METER

A. As provided by utility company.

2.3 GAS PRESSURE REGULATOR

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 required.

B. Provide vent-limited or vented gas pressure regulators as required by appliance served. Vented regulators shall be piped to vent to outdoors per jurisdictional requirements.

2.4 FLEXIBLE HOSE GAS CONNECTORS AND QUICK COUPLERS

A. Manufacturers:

Flexible Connector: Thermo-Tech Products Co. or approved equal.

Quick Coupler: Hansen Manufacturing Co. "Gas Mate" or approved equal.

B. Description:

Flexible Connector: Corrugated type 304 stainless steel flexible pipe with stainless steel braid and heavy flexible armor shield.

Quick Coupler: One way quick coupler with gas rating in cubic feet per hour equal to equivalent gas appliance rating.

PART 3 EXECUTION

3.1 GENERAL

- A. Welding, wiring, sleeves, plates and closures, foundations and pads, excavation and backfill, cutting and patching and installation of piping, valves, pipe hangers, supports, expansion compensators and identification shall be in accordance with Section 230529 - Basic Mechanical Materials and Methods.
- B. Provide all fuel gas piping from source to each connection point of all gas fired equipment items listed in "Related Work" paragraph in Part 1. Provide drip leg and gas cock or valve for each equipment item. Make final connections in compliance with equipment manufacturer's instructions. Flexible connections will not be allowed except where explicitly specified.

3.2 PIPING

- A. General:
 - 1. Install fuel gas distribution piping in accordance with jurisdiction codes and local Utility Company requirements and in conformity with standards listed in "References" paragraph in Part 1.
 - 2. Install "Tee" fitting with bottom outlet fitted with full size 6" long nipple and capped, at bottom of pipe risers or drops.
 - 3. Use dielectric unions where dissimilar metals are joined together.
 - 4. Use Teflon joint seal on metal gas piping threads, make up with 3 threads showing.
 - 5. Remove cutting and threading burrs before assembling piping.
 - 6. Do not install defective piping or fittings. Do not use pipe with threads which are chipped, stripped or damaged.
 - 7. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping, or equipment connections are completed.
 - 8. Connections to all gas-fired equipment shall include a union downstream of the manual gas shut-off valve.
 - 9. For piping buried in building substrate, or below floor slabs, install in welded conduit, ventilated to outdoors on both ends, and tested to same requirements as gas piping.
 - 10. For buried piping outside of building walls, piping shall rise out of ground 12" before penetrating building wall.
 - 11. Provide exterior gas piping and fittings with primed and painted surface. Coordinate color with Owner, Architect, and authority having jurisdiction.
- B. Buried Piping: Welded and wrapped with joints left exposed until testing has been accepted. Bury 24" below grade minimum.

C. Wrapping:

1. Provide factory applied pipe wrap in accordance with standard of serving utility company. Hand wrap or machine wrap buried exterior gas piping with Scotchwrap 10 mil PVC tape using 50% overlap wrap minimum. Double wrap fittings and joints. Extend fitting wrapping not less than 6 inches past the end of the fitting onto the pipe section. Test pipe and fittings prior to wrapping fittings. Coat steel and iron pipe with Scotchwrap pipe primer before wrapping.
2. Pipe wrapping shall conform to the following schedule:

Pipe Size	Tape Width	Scotchwrap No.	
		Standard	Cold
1/4 - 3/4 inch	1 inch	50	40
1 - 1-1/2 inch	2 or 4 inch	50	40
2 inch and larger	4 inch	50	40
Color Backing		Black	Green

3. During application of wrap, if the ambient temperature is 40 deg.F or less, use only Scotchwrap No. 40 tape. If ambient temperature is 41 deg.F or more, use only Scotchwrap No. 50.

- D. Buried Pipe Identification: Install bright colored continuously printed plastic ribbon tape of not less than 6 inches width and 4 mil thickness 6 to 8 inches below finished grade directly over buried pipe. Provide metalized tape over non-metallic pipe.
- E. Interior Concealed Piping: All pipe and fittings shall be welded. Do not install valves of any type in air plenums or concealed spaces.

3.3 HANGERS AND SUPPORT SYSTEMS (Interior)

- A. Provide pipe hangers, supports and accessories in accordance with Section 230529 - Basic Mechanical Materials and Methods.

3.4 ROOF SUPPORTS AND ANCHORS

- A. Approved Manufacturers: Miro, Mapa.
- B. Provide pipe supports spaced per Hanger Specifications in Section 230529 - Basic Mechanical Materials and Methods. Provide pipe straps to anchor pipe to supports.
- C. Provide pipe expansion loops as shown and required to eliminate pipe stress due to thermal expansion imposed by solar influence.
- D. See details on Drawings.

3.5 VALVES

- A. Provide valves in accordance with Section 230529 - Basic Mechanical Materials and Methods.

3.6 GAS COCKS AND GAS VALVES

- A. Provide at supply runout connection for each gas-fired equipment item; and on risers and branches where indicated.
- B. Locate gas cocks and valves where easily accessible, and where they will be protected from possible damage.

3.7 GAS SERVICE

- A. Complete arrangements with Utility Company to provide gas service to indicated location with shut-off at terminus.
- B. Extend service pipe from Utility's terminus to inside building wall, under Utility's direction.
- C. Provide shut-off outside building where indicated, in adjustable gas service valve box, with cover set flush to finished grade.
- D. Provide shut-off in gas service pipe at entry in building, extend pipe to gas meter location indicated; provide parts and accessories required by Utility to connect meter.

3.8 GAS METER

- A. Be responsible to verify with utility company the size and thickness, reinforcing and location of all concrete pads, chain link enclosures, gate requirements, bar-hasp-padlock requirements, and size and type of traffic bollards-guards required.
- B. Provide concrete pad in accordance with Section 230529 - Basic Mechanical Materials and Methods.
- C. Provide enclosures, bumper protection or other accessories which may be required.
- D. Install gas meter in accordance with local Utility Company's installation instructions, and comply with requirements of jurisdictional codes.

3.9 GAS PRESSURE REGULATOR

- A. Install as indicated; comply with Utility requirements. Pipe atmospheric vent to outdoors (unless a vent-limited regulator is used), full size of outlet. Install gas shut-off valve upstream of each pressure regulating valve.

3.10 FLEXIBLE HOSE GAS CONNECTORS AND QUICK COUPLERS

- A. Provide flexible stainless steel connectors with full size quick coupler for all kitchen and heavy movable gas appliance equipment.
- B. Connectors shall be of lengths required to displace equipment for complete cleaning under and around gas appliance.
- C. Provide lubricated plug valve at service connection on equipment branch and quick coupler at service end of flexible hose connector.
- D. Provide union connection on appliance or on manifold end of hose connection.

3.11 TESTS

- A. General: Test fuel supply lines with air under pressure before being covered. Use a calibrated, certified static gauge graduated to one pound per square inch.
- B. Testing shall be of the complete piping system, before covering, or of individually separable larger portions of the system. Only the last connection to the appliance may be tested under operating conditions. This connection will be tested with soap and brush under line pressures. This connection must remain exposed.
- C. Test Procedures: Use either of the following methods at the Contractor's option:
 - 1. 30 psig air pressure for a period of 24 hours with no drop in gauge pressure, indicating the line to be airtight.
 - 2. 100 psig air pressure, with joints tested with standard soap and brush inspection and maintain for 3 hours without drop in pressure.
- D. Retesting: Retest piping failing initial tests following correction of defective work. Requirements of initial tests shall apply.
- E. Test Records: Record pressure and ambient temperature at start and end of test. Submit written results of test to the Architect/Engineer.

END OF SECTION 231123

**SECTION 232113
HVAC PIPING AND SPECIALTIES**

PART 1 - GENERAL

1.1 RELATED WORK

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.
- B. Related work specified in other Sections:
 - Section 230500 - Basic Mechanical Requirements
 - Section 230529 - Basic Mechanical Materials and Methods
 - Section 230540 - Mechanical Sound and Vibration Control
 - Section 230548 - Mechanical Seismic Control
 - Section 230593 - Testing, Adjusting and Balancing
 - Section 230700 - Mechanical Insulation
 - Section 230900 - Electronic Controls
 - Section 232123 - HVAC Pumps
 - Section 233100 - Air Distribution
 - Section 233400 - Air Handling Fans
 - Section 235216 - Condensing Boilers
 - Section 235700 - Heat Transfer
 - Section 236400 – Refrigeration
- C. Work installed but furnished under other Sections:
 - 1. Condenser water bypass valve.
 - 2. Pot Feeders, Water Meters, Solenoid Water Valves with Strainers and Manifolds furnished under Section 232500 - HVAC Water Treatment.
 - 3. Flexible pipe connectors - Section 230540.
 - 4. Flow switches in the chilled and condenser water piping.
 - 5. Two-way automatic control valves.
 - 6. Three-way automatic control valves.
 - 7. Cabinet heater aquastat.
 - 8. Unit heater aquastat.
 - 9. Temperature sensing wells.

1.2 SYSTEM DESCRIPTION

- A. The work includes, but is not limited to the following:
 - 1. Hot water heating piping system and specialties.
 - 2. Chilled water piping system and specialties.
 - 3. Condenser water piping system and specialties.
 - 4. Relief Valves.
 - 5. Bladder-Type Expansion Tanks.
 - 6. Air Vents.
 - 7. Air Separators.
 - 8. Strainers
 - 9. Pump Suction fittings.
 - 10. Radiator Valves.
 - 11. Valves in accordance with Section 230529.

12. Pipe hangers and supports, saddles and shield in accordance with Section 230529.
13. Expansion joints, anchors and guides.
14. Mechanical sound and vibration control in accordance with Section 230540.
15. Antifreeze glycol treatment and specialties.
16. Installation of automatic control valves.
17. Flow Measuring Stations.
18. Water Meters.
19. Tests.

1.3 QUALITY ASSURANCE

- A. Welder Qualifications: Welding shall be performed by an NCPWB Certified Welder with current certificate in accordance with ANSI B31.9 for shop and project site welding of piping work.

1.4 REFERENCES

- A. Reference Standards: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:
 1. Comply with American Welding Society (AWS) National Certified Pipe Welding Bureau (NCPWB) and American National Standards Institute (ANSI) Code Numbers B31.2, B31.9 as applicable for welding requirements.
 2. Comply with American National Standards Institute (ANSI B31.1) Code for Pressure Piping.
 3. ANSI/ASME - Boiler and Pressure Vessel Code.
 4. ANSI/ASME B31.9 - Building Services Piping.
 5. ANSI/AWS D1.1 - Structural Welding Code.
 6. ANSI/ASME Sec. 9 - Welding and Brazing Qualifications.
 7. ASTM B32 - Solder Metal.
 8. ANSI/AWS A5.8 - Brazing Filler Metal.

1.5 SUBMITTALS

- A. Submit Product Data for the following items under provisions of The General Conditions of the Contract.
 1. Bladder-Type Expansion Tanks.
 2. Air Separators.
 3. Strainers.
 4. Flow Indicators.
 5. Flow Measuring Stations.
 6. Flow Meters.
 7. Balancing Valves.
 8. Thermometers.
 9. Pressure Gauges.
 10. Expansion Joints and Guides.
 11. Backflow Preventer.
 12. Blowdown Separator.
 13. Pressure Regulating Valves.
 14. Water Meters.

- B. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500.
1. Bladder-Type Expansion Tanks.
 2. Air Separators.
 3. Strainers.
 4. Flow Indicators.
 5. Flow Measuring Stations.
 6. Flow Meters.
 7. Balancing Valves.
 8. Water Meters.
 9. Expansion Joints and Guides.
 10. Backflow Preventer.
 11. Blowdown Separator.
 12. Pressure Regulating Valves.
- C. Test Reports: Submit certified test reports for the following showing compliance in accordance with the General Conditions of the Contract:
1. Piping pressure tests.
 2. Piping systems cleaning and flushing per Section 232500.
 3. Certificates: Before proceeding with the Work, submit to the Architect/Engineer/Construction Manager/General Contractor, two copies of Certification that the welding work will be done according to ANSI B31.1 by welders who have been tested and whose qualification test sheets are available, attesting to their ability to weld in accordance with Standard Procedure Specifications as established by the National Certified Pipe Welding Bureau.

1.6 PROJECT CONDITIONS

- A. Contractor shall not fabricate or install any piping until he has assured himself that the piping can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

1.7 GLYCOL MAINTENANCE SERVICE

- A. Provide the services of a fully qualified Field Superintendent and technical assistance for one year warranty period. Services and assistance shall include the following:
1. A training session for the Owner's operating personnel instructing them clearly and fully on the installation, maintenance and testing of the Glycol Systems.

2. A bi-annual technical service visit to the jobsite to make glycol fluid concentration analysis on site with a refractive index measurement instrument. The Field Superintendent shall detail findings with the proper personnel in writing on proper practices and any corrective actions needed to protect the Glycol Systems with the proper concentrations of glycol and inhibitors.
3. Include in the analysis the amount of Inhibited Propylene Glycol to be added or diluted to obtain the correct concentration specified for each system containing glycol.

1.8 EXTRA STOCK

- A. Glycol: Provide sufficient Inhibited Propylene Glycol to maintain specified concentrations in HVAC Piping Systems during one year warranty period.

PART 2 PRODUCTS

2.1 HEATING WATER, CHILLED WATER, CONDENSER WATER PIPING (LESS THAN 90 PSIG)

- A. Steel Pipe:
 1. Pipe:

2 Inch & Smaller	ASTM A53, Grade A, Schedule 40 black buttweld or continuous welded steel.
2-1/2 Inch & Larger	ASTM A53, Grade B, Schedule 40 black buttweld or continuous welded steel.
 2. Fittings:

2 Inch & Smaller	ASTM A197, Class 150 black malleable iron screwed.
2-1/2 Inch & Larger	ASTM A234, Steel butt weld, standard weight forged fittings.
 3. Unions:

2 Inch & Smaller	Class 150 black malleable iron screwed bronze to iron, ground joint.
2-1/2 Inch & Larger	Use flanges or grooved couplings.
 4. Gaskets:

All Sizes	Class 250 1/8 inch full faced metal spiral wound, 304 stainless steel and flexible graphite filled with entering ring and inner ring.
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 5. Bolting:

	ASTM A307, Grade B, regular square head machine bolts with heavy hex nuts.
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6. Flanges:
All Sizes ASTM A181, Grade 1, Class 150 slip-on or weld neck flat faced.

B. Copper Tubing:

1. Tube:
Up to 4" inclusive ASTM B 88, Type L, hard drawn.
2. Fittings:
 - a. ANSI/ASME B16.23 cast brass and/or
 - b. ANSI/ASME B16.29 solder wrought copper
3. Joints:
 - a. ASTM B32, solder, Grade 95 TA.

2.2 HEATING WATER, CHILLED WATER, AND CONDENSER WATER PIPING FOR GROOVED PIPE OPTION

- A. General: At Contractor's option, heating water and condenser water and chilled water piping may be mechanical roll grooved pipe couplings, fittings and butterfly valves. Cut grooves are not allowed.
- B. Acceptable Manufacturers: Victaulic, Anvil/Gruvlok, Grinnell.
- C. Water piping includes risers, mains, equipment connections, branches, supply and return lines under operating conditions not exceeding minus 30 degrees Fahrenheit to plus 230 degrees Fahrenheit.
 1. Couplings: Line and fitting joints to be Victaulic "Style 75 or 77" with Grade "E" gaskets and nuts and bolts. Rated -30°F. to 230°F.
 2. "Rigid" line fitting and valve joints to be Victaulic "Style S-07" Couplings with or Grade "E" gaskets and nuts and bolts.
 3. Joints designated Outlet Couplings to be Victaulic "Style 72" with Grade "E" gaskets and nuts and bolts.
 4. Joints designated Reducing Couplings to be Victaulic "Style 750" with Grade "E" gaskets and standard nuts and bolts.
 5. Flanged components connections to be Victaulic "Style 741 Vic-Flanges" with Grade "E" gaskets.
 6. Fittings: Fittings to be Victaulic "Full Flow" malleable iron or ductile iron or segmentally welded fittings, with grooved or shouldered ends.
 7. Valves: Butterfly valves 2" - 12" inch to be Victaulic S/300 with 300 psi rating, latch-lock throttling handles, Grade "E" linings and standard trim. Sizes 14" - 24" to be Victaulic S/708 with 175 psi rating. Valves greater than or equal to 8" shall be supplied with gear operator.
 8. Check valves shall be series 716 or 716H. Pressure drop across check valve at design flow shall not exceed 1.5 psi.
 9. All materials to be manufactured in the USA, and must be designed and intended for use on HVAC systems. No fire sprinkler parts are allowed.

2.3 STATIONARY PRESSURE GAUGES

- A. Acceptable manufacturers: Miljoco, Trerice 600C Series, Weiss Instruments, Weksler Glass, Weksler Instrument Regal Series.
- B. Schedule:

Type	4-1/2" Dial	4-1/2" Dial
Bourdon tube/socket	Phosphor bronze tube brass socket	Stainless steel tube 316 stainless steel socket
Accuracy	ASME B40.1 Grade 1A 1% FS over middle half of range	ASME B40.1 Grade 1A 1% F.S. over middle half of range
Case	Cast aluminum	Cast aluminum
Window	Clear glass	Clear glass
Snubber	Yes	Yes
Coil siphon	For steam service	For steam service
Gauge cock	Yes	Yes

- C. Range: Select gauges for the following standard ranges unless otherwise indicated on drawings, or as required for special systems:
1. Domestic Water 0 to +160 psi
 2. Pump Gauges -30 in Hg to +100 psi

2.4 STATIONARY THERMOMETERS

- A. Acceptable manufacturers: Ametek Industrial Series, Miljoco, Trerice Industrial Series, Weiss Instruments, Weksler Glass, Weksler Instrument.
- B. Schedule:

Type	Adjustable angle	Rigid
Case	9" cast aluminum	9" cast aluminum
Window	Clear acrylic	Clear acrylic
Tube	Lens front, magnifying	Lens front, magnifying
Stem	Aluminum, insertable	Aluminum, insertable
Separable Thermowell	Brass	Brass
Fill Type	Spirit: Blue colored, organic	Spirit: Blue colored, organic
Accuracy	+/- 1% of Full Scale	+/- 1% of Full Scale

- C. Range: Select thermometers, for the following standard ranges unless otherwise indicated on Drawings, or as required for special systems.
1. Chilled water 0 to 100 °F
 2. Condenser water 0 to 100 °F
 3. Heating water 30 to 240 °F

2.5 TEMPERATURE AND PRESSURE TEST PLUGS (T&PTP)

- A. Manufacturer: Trerice, Fairfax, Flow Design, Peterson Equipment (Pete's Plug), Sisco.
- B. Plugs suitable for vacuum to 600 psig and temperatures of -20 deg.F to 300 deg.F with cap and extension for insulated pipe where required.
- C. Provide one pressure gauge(s), gauge adapter, and two thermometers in shock-proof case.
- D. Schedule:

MAKE:	MODEL:	PRESSURE & TEMPERATURE TEST KIT
Trerice	D3741	Trerice D3750 (0-100 psig)

2.6 EXPANSION JOINTS, ANCHORS AND GUIDES

- A. Approved Manufacturers: Barco, Flex-Hose, Metraflex, Hyspan, Twin City Hose.
- B. Provide expansion joints where called for on drawings or otherwise necessary to prevent noise or damage.
- C. Exposed Bellows Expansion Compensator: Stainless steel bellows with internal stainless steel liner, carbon steel ANSI flanges or Schedule 80 beveled weld ends as indicated in schedules. Include tie rods with spacers to prevent over-elongation and over-compression of the unit. Expansion compensator must be rated for operating temperatures up to 600°F and operating temperatures up to 150 psi.
- D. Externally Pressurized Expansion Compensators: Stainless steel multi-ply bellows with internal guides, internal stainless steel liner, and a heavy wall outer housing designed for line pressure. Operating fluid pressure inside compensator is transferred to the outside of the bellows through a gap between internal guide flange and the outer housing. Entire assembly to be sealed to contain fluids and pressure, and shall include a drain port in the outer housing. Unit to be rated for operating pressure of 150 psi and operating temperature up to 700°F. Unit to be a packless design, maintenance free design. Guarantee a minimum of 10,000 full travel cycles without failure. Use Metraflex Metragator, Flex-Hose Flexpress, or equal from list of approved manufacturers.
- E. Braided Pipe Seismic Connectors: Two or three equal lengths of annular corrugated flexible stainless steel hose with stainless steel overbraid and four stainless 90° elbows, resulting in a device that absorbs/compensates for pipe motion in all 6 degrees of freedom simultaneously. Device shall allow for ± 4" of pipe motion in any direction. Unit to be rated for operating pressures of 150 psi and operating temperatures of 600°F. Include support lugs on elbows and fitting on distant elbow for drain plug or air relief valve. Use Flex-Hose, Tri-Flex Loop or equal from list of approved manufacturers.

- F. In-Line Seismic Pipe Joint: Externally pressurized expansion compensators with two gimbals or ball joints. Working pressure rating not less than 150 psig at 400 °F, factory tested to 225 psig at 500°F.
1. Bellows to accommodate axial motion: Stainless steel multi-ply bellows with internal guides, internal stainless steel liner, and a heavy wall outer housing designed for line pressure. Operating fluid pressure inside compensator is transferred to the outside of the bellows through a gap between internal guide flange and the outer housing. Entire assembly to be sealed to contain fluids and pressure, and shall include a drain port in the outer housing. Include lifting lugs. Unit to be a packless design, maintenance free design. Guarantee a minimum of 10,000 full travel cycles without failure.
 2. Gimbals to accommodate lateral motion: Carbon steel gimbal joint at either end of bellows. Include braided stainless steel flexible connector within stainless bellow internals at each gimbal joint.
 3. Ball joints to accommodate lateral motion: Wrought steel ball, case, and retainer, with chrome and molybdenum disulfide plated sealing surfaces. Seals rated for service temperatures from -50°F to 525°F
 4. Approved Devices: Metraflex Seismic Gator, Hyspan Barco Series 3500 IS.
- G. Pipe Guides: Provide pipe guides and anchors as shown on drawings or as recommended by expansion joint manufacturer. Pipe guides must allow axial movement of pipe while eliminating lateral pipe movement. Guides to be constructed of painted carbon steel, and consist of a two-piece split spider clamp that bolts around the pipe, and a two-piece bolted split housing with integral base that anchors the unit to the structure. Pipe anchors shall be made of carbon steel, are to be welded to the pipe they serve, and are to be painted to protect the anchor and welds from corrosion. Anchors to include an integral base that bolts to the structure.

2.7 FLANGES, UNIONS, AND COUPLINGS

- A. Pipe Size 2 Inches and Under: 150 psig malleable iron unions for threaded ferrous piping; bronze unions for copper pipe, soldered joints.
- B. Pipe Size Over 2 Inches: 150 psig forged steel slip-on flanges for ferrous piping; bronze flanges for copper piping; 1/16 inch thick preformed neoprene bonded to asbestos.
- C. Grooved and Shouldered Pipe End Couplings: Malleable iron housing clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; C-shape elastomer composition sealing gasket for operating temperature range from -30 degrees F to 230 degrees F; steel bolts, nuts, and washers; galvanized couplings for galvanized pipe.

2.8 RELIEF VALVES

- A. Acceptable Manufacturers: Kunkle, Watts, McDonnell and Miller, Lonegren, Conbraco, Spirax Sarco, Spence.
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.
- C. Size as required for maximum operating pressure and heat transfer capacity of the equipment. Provide relief valve in each system to protect piping, tanks, and equipment.

2.9 PUMP SUCTION FITTINGS

- A. Acceptable Manufacturers: Bell and Gossett, Armstrong, Paco, Allis Chalmers, Weinman, Peerless, Aurora, Amtrol, Wheatley, Taco, Victaulic, Gruvlok, Patterson, Spence.
- B. Pump suction fitting shall match specified pump provided by Contractor.
- C. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, or grooved fittings for grooved pipe, rated for 175 psig working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.
- D. Maximum allowable pressure drop across pump suction fitting at system design flow is 1 psi. Provide concentric reducer as necessary to connect pump suction to pump inlet.
- E. Accessories: Adjustable foot supports, blowdown tapping in bottom, gauge tapping in side.

2.10 FLOW INDICATORS

- A. Acceptable Manufacturers: McDonnell and Miller, Mueller.
- B. Brass construction, threaded for insertion into piping system, packless, with paddle with removable segments, vapor proof electrical compartment with switches.

2.11 COALESCING-TYPE AIR SEPARATORS

- A. Acceptable Manufacturers: Amtrol, Armstrong, Bell and Gossett, Caleffi, Patterson, Spirotherm, Taco, Wheatley.
- B. Tank: Fabricated steel tank, ASME constructed and stamped, rated for a maximum working pressure not less than 150 psig and maximum operating temperature not less than 270°F. Tank shall be available with NPT end connections or ANSI class 150 flanges.
- C. Coalescing media shall be copper or stainless steel.
- D. Separator shall include a float actuated automatic air vent, a threaded port on the side of the housing (near the top) to allow floating debris to be removed, and a threaded port on the bottom of the housing to allow blow-down of sediments from the unit.
- E. Performance: Separator must remove 100% entrained air and 99% of dissolved air in fluid flowing through the device
- F. Provide air separator of size and capacity indicated on drawings.

2.12 STRAINERS

- A. Acceptable Manufacturers: Armstrong, Boylston, AW Cash, ITT, Hoffman, Keckley, Mueller, Trane, Metraflex, Victaulic, Gustin-Bacon, Conbraco, Spirax Sarco, Gruvlok, IFC, Nexus.

- B. Size 2 inch and Under: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. Size 2-1/2 inch to 4 inch: Flanged or grooved iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.
- D. Size 5 inch and Larger: Flanged or grooved iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.
- E. Do not install duplicate system strainers in series with strainers that are factory installed on chillers. If shown on drawings, verify with Engineer prior to pipe installation to determine if additional strainer is required.

2.13 BLADDER-TYPE EXPANSION TANKS

- A. Acceptable Manufacturers: Amtrol, Armstrong, Bell and Gossett, Flexcon, Niles Steel Tank, Patterson, Taco, Wessels, Wheatley, Woods.
- B. Provide tanks of size and capacity shown on Drawings.
- C. Construction: Welded steel, rated for working pressure of 175 psig, and maximum operating temperature not less than 240°F. Construct, test, and stamp in accordance with section VIII, Division 1, of the ASME Boiler and Pressure Code.
- D. Bladder: Heavy-Duty replaceable butyl bladder secured and sealed into tank to separate air charge from system fluid and maintain required expansion capacity.
- E. Accessories: Stainless Schrader air valve with EPDM seats. Threaded tank drain fitting, threaded pressure gauge fitting for reading air pressure inside tank.

2.14 AIR VENTS

- A. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/4 inch copper tubing to a petcock.

2.15 RADIATOR VALVES

- A. Acceptable Manufacturers: Dunham-Bush, ITT, Hoffman, Illinois, Trane, Danfoss, Weksler, Runtal.
- B. Angle or straight pattern, rising stem, inside screw globe valve for 125 psig working pressure, with bronze body and integral union for screwed connections, renewable composition disc, plastic wheel handle for shut-off service, and lockshield key cap and set screw memory bonnet for balancing service.

2.16 GLYCOL FILL SYSTEM

- A. Mixing Tank: 45 gallon poly drum with fittings suitable for filling, low level switch, and electric pump for charging. Pressure switch actuated controls with pre-wired control panel. Control panel shall include pump H-O-A switch and push button to silence low level alarm.

2.17 INHIBITED PROPYLENE GLYCOL (Antifreeze Heat Transfer Fluid)

- A. Product: The Dow Chemical Company - Dowfrost Heat Transfer Fluid, Huntsman, JeffCool P150.
- B. Description: An inhibited propylene glycol that is clear and odorless.
- C. Provide: In specified concentrations in HVAC Water Piping Systems listed in Part 3 of this Section 232113.

2.18 PRESSURE COMPENSATING FLOW CONTROL VALVES

- A. Acceptable Manufacturer: Griswold Corporation, Febco, Bell & Gossett, Armstrong, Gerand, Spirax Sarco, Nexus
- B. Provide automatic pressure compensating flow control valves. The F.C.V. and housing shall be in a factory-assembled unit consisting of a flow controller with bronze union fittings with EPR "0" -ring seals, pressure and/or temperature plugs and ball valve. Flow control valves shall have the flow rates and pressure differential as indicated and strictly conform without exception to the following:
 - 1. The control mechanism of the F.C.V. shall be a coiled/helical spring 17-7 PH. Wave springs are not acceptable. The cartridge for the coiled/helical spring shall be stainless steel. Plated materials are not acceptable. Cartridge must be removable in one piece.
 - 2. Flow control valves must be available in four pressure differential operating ranges:
 - 1 to 14 PSI Drop
 - 2 to 32 PSI Drop
 - 3 to 57 PSI Drop
 - 4 to 128 PSI Drop
 - 3. They shall be factory calibrated and automatically limit the rate of flow to the design flow rate indicated on the Drawings within + or - 5 percent accuracy over an operating pressure differential of at least 14 times the minimum required for control.
 - 4. F.C.V. with an operating pressure differential of one range from 3 to 40 PSI Drop are not acceptable.
 - 5. F.C.V. manufacturer shall warranty to the owner the F.C.V. for a period of two years from date of purchase.
 - 6. All flow control valves shall have two union fittings to provide easy access and removal of the flow control from either the supply or return pipeline.
 - 7. Each automatic flow control valve shall be furnished with a valve kit consisting of 1/4 inch by 2 inch minimum size nipples, quick-disconnect valves (to be located outside of insulation), and fittings suitable for use with the measuring instruments specified.
 - 8. Provide a metal identification tag, with wire, for each flow control valve. The tag to be marked with zone identification, valve model number and rated flow in GPM.
 - 9. All automatic flow controls shall be factory marked to show the direction of flow.
 - 10. A flow pressure and temperature measuring kit shall be furnished to the owner upon completion of the job.

11. The pressure/temperature kit shall be portable and consist of pressure gauges, thermometer, connections and a carrying case.
12. Correct flow shall be verified by establishing that the operating pressure differential across the valve tappings is within the operating range indicated on the submittal data sheet for that model number.
13. Temperature measurement is to be determined by insertion of a thermometer into the fluid media via the temperature plug.

2.19 FLOW MEASURING STATIONS (VENTURI)

- A. Furnish and install where shown on drawings, complete Venturi Flow Measuring System as manufactured by Hyspan Barco, Flow Design, Febco, Bell & Gossett, Preso, Armstrong, Gerand, Nexus.
- B. Venturi stations shall be one-piece brass or bronze threaded 1/2" through 3". Sizes 2-1/2" through 8" shall consist of one-piece steel with weld or flanged ends. Minimum working pressure rating: 225 PSIG at 250°F.
- C. Each primary flow element shall be a Venturi selected from manufacturer's engineering data to permit prescribed flow at a minimum of head loss. Accuracy minimum +/- 1% throughout turndown ration of 10:1. Venturi sizes and beta ratios shall be selected so that design flow rates produce a differential pressure reading at the integral sensing taps between 20% and 80% of the full scale range on a linear meter. The design of the venturi shall provide pressure recovery that limits the system insertion pressure loss to not more than 25% of the differential pressure at the sensing taps.
- D. Each Venturi shall be furnished with 2 built-in pressure taps, nipples, shut-off valves, and quick connect couplings. Venturis shall be complete with identification tag on chain, giving pipe size, Venturi series, station identification and meter reading at specified flow rate. Furnish flow vs. differential pressure curves and installation instructions.
- E. Provide with portable indicating meter with 6" round dial, 270 degrees indication. It shall be the dual rupture-proof liquid filled bellows type with integral temperature compensation. The meter shall have over-range protection in either direction equal to the working pressure equivalent of the instrument housing (250 psig at 250 deg.F). The accuracy of the meter shall be no less than 0.5% full scale. The meters case shall be waterproof coated with appropriate paint. It shall have external zero and range adjusting screws and life-long lubrication. Scale shall be calibrated uniformly either in differential pressure; percent of flow; or directly in gpm.
 1. Portable Master Meters shall be mounted in a durable metal reinforced plastic carrying case with the following accessories:
 - a. Two 10" lengths of connecting hose, each with color coded quick connect couplings compatible with the Venturi couplings.
 - b. Two brass blow-down valves with Buna-N seals.
 - c. Blow-down hoses.
 - d. Instruction book with flow vs. differential curves.

2.20 CALIBRATED BALANCING VALVES (TERMINAL EQUIPMENT)

- A. Acceptable Manufacturer: Armstrong, Bell & Gossett, Danfoss, Flow Design, Gerand, Grinnell, Griswold, Gruvlok, Nexus, Niboo, Red-White, Taco, Tour & Andersson, Vitaulic.

- B. Bronze, Calibrated-Orifice, Balancing Valve: Bronze body with calibrated orifice or venturi. Throttling ball to be stainless steel or brass, plug to be resin, seats to be PTFE. End connections threaded or socket. Include two pressure gauge connections to include integral seals or check valves to prevent fluid loss when used with a portable differential pressure meter. Include throttling handle with memory stop and position indicator with indexed scale. Valve CWP rating: Minimum 150 PSIG, maximum operating temperature shall not be less than 250°F.
- C. Cast Iron or Steel, Calibrated-Orifice, Balancing Valve: Cast iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi. Stem seals to be EFDM o-rings, disc to be glass and carbon-filled PTFE, seats to be PTFE. End connections to be flanged or grooved. Include two pressure gauge connection ports with integral seals or check valves to prevent fluid loss when used with a portable differential pressure meter valve handle with memory stop and position indicator with indexed scale. Valve CWP Rating: Minimum 150 PSIG, maximum operating temperature shall not be less than 250°F.
- D. Provide a metal identification tag attached to, for each flow control valve. The tag to be marked with zone identification, valve model number, and rated flow in GPM.
- E. Correct flow shall be verified by establishing that the operating pressure differential across the valve tapings is within the operating range indicated on the submittal data sheet for that model number.

PART 3 EXECUTION

3.1 PIPE WORKMANSHIP

- A. Piping shown on the drawings shall be installed complete, and shall be of the size shown on the drawings. When a size is not indicated, the sub-contractor shall request the pipe size from the Architect/Engineer thru the General Contractor. All piping shall be installed parallel or perpendicular to the building construction. All piping shall be installed so as to allow for expansion. Install saddles and shields per Section 230529.
- B. Relief Valve: Install a 1" safety relief valve, set at a pressure no more than 5 psig less than the relief valve on boiler or chiller evaporator barrel, to protect against damage by expanding liquid or other source of overpressure during test or normal operation. Discharge of this system relief valve shall be piped to the glycol fill tank for recovery of glycol should relief valve be discharged.

3.2 PIPE SLOPE

- A. Slope all domestic water, chilled water, heating water and condenser water piping at 1"/40' toward drains.

3.3 PIPING JOINTS

- A. All pipe shall be reamed to full pipe diameter before joining. Screwed joints shall be made with standard pipe thread, and an approved compound applied to the male thread only. Welded joints shall be made in accord with the procedure outlined in National Certified Pipe Welding Bureau, or by other reputable testing laboratory or agency. Subcontractor shall use only "Threadolet" or "Weldolet" fittings for intersection welding of branches to mains. Valves and specialties shall have screwed or flanged joints. No bushings allowed.

- B. All pipe shall be reamed to full pipe diameter before joining.
- C. Pull tee (T-drill) fittings are forbidden.

3.4 SYSTEM PRESSURE SETTINGS

- A. Hot Water Heating System: Fill system to 10 psig at highest point in system. Set system pressure monitoring system to generate a low system pressure alarm when system pressure is 5 psi below fill pressure. Pre-charge bladder-type expansion tank to 2 psig less than "fill" pressure prior to connection to the system.
- B. Chilled Water System: Fill system to 10 psig at highest point in system. Set system pressure monitoring system to generate a low system pressure alarm when system pressure is 5 psi below fill pressure. Pre-charge bladder-type expansion tank to 2 psig less than "fill" pressure prior to connection to the system.

3.5 RELIEF VALVES

- A. Provide a pressure relief valve in each closed loop system set at 1.2 times the maximum operating pressure.

3.6 CHANGE IN PIPE SIZE

- A. Where changes in the pipe size are required at equipment connections, change the pipe size within a maximum length of three pipe size diameters of the final connection.
- B. Where changes in pipe size occur in horizontal straight lengths of pipe, install concentric reducers.

3.7 EXPANSION JOINTS, ANCHORS AND GUIDES

- A. Pipe anchors shall be installed as shown and at the closest feasible point to all changes in pipe direction and elevation and at main branch take-offs, except at expansion loops. All piping shall be supported, anchored, braced and guided to control expansion-contraction and pipe movement due to pressure or shock, and to result in quiet operation.

3.8 BALL JOINTS

- A. Install ball joints and anchoring for piping where it crosses expansion joints of building.

3.9 AUTOMATIC CONTROL VALVES

- A. Install automatic control valves as required and specified in Section 230900 - Electronic Controls.

3.10 AIR VENTS

- A. At all changes in elevation downward in direction of flow, and where shown, provide a manual air vent as follows: install a full size air chamber and pipe down with 1/4 inch copper tubing to a petcock. If the vent is above a ceiling, install the petcock just above the ceiling. Provide air vent fittings (manual) on hydronic coils.

3.11 CALIBRATED BALANCING VALVES

- A. Provide a calibrated balancing valve in the supply pipe to each piece of equipment and where shown on the drawings.
- B. Select calibrated balancing valves to match equipment or circuit flow rates shown on drawings. Provide pipe size reducers as necessary.
- C. Install in accordance with all manufacturer's recommendations, including minimum pipe diameters of straight pipe upstream and downstream of the balancing valve.

3.12 FLOW MEASURING STATIONS (VENTURI)

- A. Install in accordance with all manufacturer's recommendations, including minimum pipe diameters of straight pipe upstream and downstream of the Venturi.

3.13 PIPING CONNECTORS

- A. Install flexible pipe connectors at equipment coils and pumps and elsewhere as required to accommodate thermal expansion, misalignment and vibration in accordance with Section 230540 - Mechanical Sound and Vibration Control.

3.14 BLADDER-TYPE EXPANSION TANK

- A. Provide pressure gauge to read air pressure inside tank.
- B. Provide manual isolation valve and union in fluid line to expansion tank so bladder can be replaced without requiring draining of main system pipes.
- C. Provide manual ball valve and hose fitting with threaded cap at tank drain fitting.

3.15 AIR SEPARATOR

- A. Provide an air separator in each closed loop hydronic system.
- B. Pipe the bottom blow-down port and side flush port for floating debris to the nearest floor sink. Provide a manual ball valve for each port and install so they can be operated by maintenance staff standing at floor level.

3.16 STRAINERS

- A. Provide a strainer in the supply pipe just upstream of each piece of equipment or control valve that does not already have a factory installed strainer.
- B. Remove and clean all strainer screens after 24 hours of system operation, and again after 30 days.

3.17 FLOW SWITCHES

- A. Contractor shall furnish and install flow switches for mounting in chilled water and condenser water piping of each chiller machine.

3.18 THERMOMETERS AND GAUGES FOR CHILLER, BOILER, HEAT EXCHANGER INSTALLATION

- A. Contractor shall furnish and install a set of four adjustable, indicating type, mercury filled thermometers of the separable socket adjustable type in glass faced metal cases. They shall be placed in the piping adjacent to the machine in the following locations:
 - 1. Condenser water line entering condenser.
 - 2. Condenser water line leaving condenser.
 - 3. Heating water line entering boiler.
 - 4. Chilled water line entering cooler.
 - 5. Domestic water line entering heat exchanger.
 - 6. Heating water line leaving boiler.
 - 7. Chilled water line leaving cooler.
 - 8. Domestic water line leaving heat exchanger.
 - 9. Where indicated on plans, details and schematics.
- B. Thermometer bulb shall project sufficiently into pipe (at least 1/3 of nominal pipe diameter) to accurately measure water temperature. Cases shall clear insulation.
- C. Contractor shall provide and install gauge valves and gauges so that water pressure difference across these vessels is indicated.
- D. Mount thermometers and gauges in a readily accessible location and easily read in a standing position from the equipment room floor.
- E. Provide a shut-off valve on the branch line to each pressure gauge located in the system.

3.19 BACKFLOW PREVENTER

- A. Provide on cold water make-up line to heating water and chilled water piping systems. Locate on high pressure side of reducing valve on system water make-up line.

3.20 TESTS

- A. General: Provide test pump, gauges, meters, other instruments, materials, and labor, in connection with tests.
- B. Relief Valve: Install a 1" safety relief valve, set at a pressure no more than 5 psig less than the relief valve on boiler or chiller evaporator barrel, to protect against damage by expanding liquid or other source of overpressure during test or normal operation. Discharge of this system relief valve shall be piped to the glycol fill tank for recovery of glycol should relief valve be discharged.
- C. Pressure Tests: Before testing piping systems, remove or otherwise protect from damage, control devices, air vents and other parts which are not designed to stand pressure used in testing piping.

- D. Hydrostatic Pressure: Test hydronically, piping for all services (except pneumatic system compressed air) to 125 psi or 1.5 times the maximum working pressure, whichever is greater, for at least six consecutive hours, during which time pressure shall remain constant without pumping. Subject welded joints to the hammer test, and copper joints to soap suds while under hydrostatic pressure.

3.21 CLEANING OF PIPING SYSTEMS

- A. Provide for the cleaning of the HVAC Water Piping Systems after hydrostatic tests have been completed and prior to the operating tests in accordance with Section 232500 - HVAC Water Treatment.
- B. 232113 Contractor is to provide bypasses and isolation valves as required by 232500 Contractor to allow circulation of cleaning solution in new piping system without allowing system cleaning solution to circulate through existing piping system. Division 232113 Contractor is responsible for removing and cleaning strainers in new or existing system plugged by cleaning of new system. Simply blowing down strainers is unacceptable.

3.22 ANTIFREEZE GLYCOL TREATMENT

- A. After each system has been cleaned and flushed as described in "CLEANING OF PIPING SYSTEMS", it shall be filled with a solution of water and the following percentage by volume of inhibited propylene glycol:

Chilled Water System	30%
Heating Water System	30%

- B. Provide inhibited propylene glycol of type and formula specified for use in above described systems. Do not use any of the following:
 - 1. Ethylene glycol
 - 2. Standard automotive anti-freeze
 - 3. Any solution with oil-base additives

3.23 HVAC WATER TREATMENT

- A. Provide valved tees and piping and 3/4 inch threadlets for water treatment apparatus in accordance with Section 232500 HVAC Water Treatment Contractor instructions.

END OF SECTION 232113

**SECTION 232123
HVAC PUMPS**

PART 1 GENERAL

1.1 RELATED WORK

- A. The General Conditions, Supplementary Conditions and Division 1 General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.
- B. Related work specified in other Sections:
 - Section 230500 - Basic Mechanical Requirements
 - Section 230529 - Basic Mechanical Materials and Methods
 - Section 230540 - Mechanical Sound and Vibration Control
 - Section 230548 - Mechanical Seismic Control
 - Section 230593 - Testing, Adjusting and Balancing
 - Section 230700 - Mechanical Insulation
 - Section 230900 - Electronic Controls
 - Section 232113 - HVAC Piping and Specialties
 - Section 233400 - Air Handling Fans
 - Section 235216 – Condensing Boilers
 - Section 235700 - Heat Transfer
 - Section 236400 - Refrigeration

1.2 SYSTEM DESCRIPTION

- A. The work includes, but is not limited to, providing the following:
 - 1. Close-coupled, in-line centrifugal pumps.
 - 2. Separately coupled, vertically mounted, in-line centrifugal pumps.
 - 3. Wet-rotor in-line centrifugal pumps.
 - 4. Close-coupled, base-mounted, end-suction centrifugal pumps.
 - 5. Separately-coupled, base-mounted, end-suction centrifugal pumps.
 - 6. Separately-coupled, base-mounted, double-suction centrifugal pumps.
 - 7. Vertical turbine, in-line, multi-stage, casing diffuser centrifugal pumps.

1.3 REFERENCES

- A. Reference Standards: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:
 - 1. Comply with American National Standards Institute ASME B31.9 Code for Pressure Piping.
 - 2. Pump definitions in accordance with ANSI/HI 1.1-1.2 and 1.3.

1.4 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings and Product Data including materials of construction, actual impeller size, pump speed, motor size, motor efficiency, motor amps, mounting requirements, weights, dimensioned drawings, and performance curves at scheduled flow conditions, for the following items in accordance with the General Conditions of the Contract:
 - 1. All pumps.
- B. Operating Instructions and Maintenance Data: Submit printed Operating Instructions and Maintenance Data for the following items in accordance with Operating and Maintenance Data paragraph in Section 230500.
 - 1. All pumps.

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.
- B. Non-Overloading Motors: Motors shall be selected for continuous operation without exceeding the full load nameplate rating over the entire pump curve, exclusive of service factor.
 - 1. Pumps operating with a variable frequency drive and identified to be equipped with a full-size impeller may not be operating at the motor synchronous speed when producing the scheduled flow and head. Select motors for these pumps to meet the brake horsepower demand when operating at the necessary RPM to satisfy the scheduled flow and head.

2.2 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

- A. Acceptable Manufacturers: Armstrong, Bell & Gossett, Grundfoss, Paco, Patterson, Taco, Weinman.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

C. Pump Construction:

1. Casing: Radially split to allow removal of the rotating elements without disturbing the pipe connections, cast iron, rated minimum 175 psig working pressure at continuous operating temperature not less than 225°F. Threaded gage tappings at inlet and outlet, and threaded companion-flange or union-end connections. The casing shall be hydrostatically tested to 150% rated working pressure.
2. Impeller: ASTM B 584 cast bronze, or stainless steel; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.
 - a. Where indicated on the pump schedule, trim impeller to match specified performance. This requires an initial flow/head reading with throttling valve 100% open. Contractor will provide this information to the pump factory, which will calculate the necessary impeller trim to achieve design flow within +10%/-0% without use of throttling valve. Contractor will remove impeller, provide trim, then reinstall impeller. Test & Balance contractor will then perform final balance.
 - b. Where indicated on schedule, pumps operating with variable frequency drive to be provided with largest size impeller for volute of pump. Ensure motor is capable of meeting BHP duty at RPM necessary to meet design flow/head. Modify pump selection or motor synchronous speed as necessary.
3. Pump Shaft: Stainless steel, or steel with stainless steel shaft sleeve.
4. Seal: Mechanical seal consisting of carbon rotating ring against a silicon carbide seat held by a stainless-steel spring. Provide with bellows and gasket made from materials suitable for the fluids and operating temperatures in the systems served. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings; or oil lubricated, bronze-journal or thrust type.

D. Motor: Single speed and rigidly mounted to pump casing.

1. 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. Comply with requirements for motors specified in Section 230529 – Basic Mechanical Materials and Methods.
3. Shaft Grounding: Provide motor shaft grounding kit on all pumps operating with variable frequency drives with motors larger than 3 HP.

E. Capacities and Characteristics: See schedule on drawings.

2.3 SEPARATELY COUPLED, VERTICALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

- A. Acceptable Manufacturers: Armstrong, Bell & Gossett, Paco, Patterson, Taco, Weinman
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically.

- C. Pump Construction:
1. Casing: Radially split to allow removal of the rotating elements without disturbing the pipe connections, cast iron, rated minimum 175 psig working pressure at continuous operating temperature not less than 225°F. Threaded gage tappings at inlet and outlet, and threaded companion-flange or union-end connections. The casing shall be hydrostatically tested to 150% rated working pressure
 2. Impeller: ASTM B 584 cast bronze, or stainless steel; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.
 - a. Where indicated on the pump schedule, trim impeller to match specified performance. This requires an initial flow/head reading with throttling valve 100% open. Contractor will provide this information to the pump factory, which will calculate the necessary impeller trim to achieve design flow within +10%/-0% without use of throttling valve. Contractor will remove impeller, provide trim, then reinstall impeller. Test & Balance contractor will then perform final balance.
 - b. Where indicated on schedule, pumps operating with variable frequency drive to be provided with largest size impeller for volute of pump. Ensure motor is capable of meeting BHP duty at RPM necessary to meet design flow/head. Modify pump selection or motor synchronous speed as necessary.
 3. Pump Shaft: Stainless steel, or steel with stainless steel shaft sleeve.
 4. Seal: Mechanical seal consisting of carbon rotating ring against a silicon carbide seat held by a stainless-steel spring. Provide with bellows and gasket made from materials suitable for the fluids and operating temperatures in the systems served. Include water slinger on shaft between motor and seal.
 5. Pump Bearings: Permanently lubricated ball bearings.
- D. Shaft Coupling: Rigid, axially split spacer coupling. Heavy cylindrical bracket between motor and pump casing to include openings of generously sized to allow for removal and replacement of coupling, gland, and seal without disturbing the motor, pump, or supply and return water piping. Rigid coupling designed to automatically place motor and pump shaft within factory tolerances without the need for shaft alignment.
- E. Motor: Single speed. Rigidly mounted to pump casing by means of heavy cylindrical bracket with 360° register on each flange. Motor includes with lifting eyebolt and supporting face in motor enclosure.
1. 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. Comply with requirements for motors specified in Section 230529 – Basic Mechanical Materials and Methods.
 3. Shaft Grounding: Provide motor shaft grounding kit on all pumps operating with variable frequency drives with motors larger than 3 HP.
- F. Capacities and Characteristics: See schedule on drawings.

2.4 WET ROTOR IN-LINE CENTRIFUGAL PUMP

- A. Acceptable Manufacturers: Armstrong, Bell & Gossett, Flowserve, Grundfos, Taco.
- B. Description: Factory-assembled and -tested, wet-rotor pump. Pump and motor to form an integral unit with bearings lubricated by the pumped liquid.
- C. Pump Construction:
 - 1. Body: Lead-free bronze, stainless steel, or cast iron.
 - 2. Impeller: Polymer or stainless steel.
 - 3. Pump Shaft: stainless steel.
 - 4. Bearings: Double-sintered carbon.
 - 5. Max operating pressure not less than 150 psig. Max operating temperature not less than 230°F
- D. Motor: Variable speed, rigidly mounted to pump housing.
 - 1. 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. Comply with requirements for motors specified in Section 230529 – Basic Mechanical Materials and Methods.
 - 3. EC Motor with integral variable-speed control.
- E. Capacities and Characteristics: See schedule on drawings.

2.5 CLOSE-COUPLED, BASE MOUNTED, END SUCTION CENTRIFUGAL PUMPS

- A. Acceptable Manufacturers: Armstrong, Bell & Gossett, Grundfos, Paco, Patterson, Taco, Weinman.
- B. Description: Factory-assembled and tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.
- C. Pump Construction:
 - 1. Casing: Radially split, cast iron, with drain plug at bottom and air vent at top of volute, threaded gauge tappings at inlet and outlet, and threaded companion-flange or flanged connections. Maximum working pressure not less than 175 psig at continuous operating temperature not less than 225°F.
 - 2. Impeller: ASTM B584 cast bronze, or stainless steel; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.
 - a. Where indicated on the pump schedule, trim impeller to match specified performance. This requires an initial flow/head reading with throttling valve 100% open. Contractor will provide this information to the pump factory, which will calculate the necessary impeller trim to achieve design flow within +10%/-0% without use of throttling valve. Contractor will remove impeller, provide trim, then reinstall impeller. Test & Balance contractor will then perform final balance.

- b. Where indicated on the pump schedule, pumps operating with variable frequency drive to be provided with largest size impeller for volute of pump. Ensure motor is capable of meeting BHP duty at RPM necessary to meet design flow/head. Modify pump selection or motor synchronous speed as necessary.
- 3. Pump Shaft: stainless steel, or steel with stainless steel shaft sleeve.
- D. Seal: Mechanical seal consisting of carbon rotating ring against a silicon carbide seat held by a stainless-steel spring. Provide with bellows and gasket made from materials suitable for the fluids and operating temperatures in the systems served. Include water slinger on shaft between motor and seal.
- E. Motor: Single speed and rigidly mounted to pump casing.
 - 1. 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. Comply with requirements for motors specified in Section 230529 – Basic Mechanical Materials and Methods.
 - 3. Shaft Grounding: Provide motor shaft grounding kit on all pumps operating with variable frequency drives with motors larger than 3 HP.
- F. Capacities and Characteristics: See schedule on drawings.

2.6 SEPARATELY COUPLED, BASE MOUNTED, END SUCTION CENTRIFUGAL PUMPS

- A. Acceptable Manufacturers: Armstrong, Bell & Gossett, Grundfoss, Paco, Patterson, Taco, Weinman.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump with flexible shaft coupling as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.
- C. Pump Construction:
 - 1. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and threaded companion-flange or flanged connections. Maximum working pressure not less than 175 psig at continuous operating temperature not less than 225°F.
 - 2. Provide integral mount on volute to support the casing and to allow removal and replacement of impeller without disconnecting piping or requiring realignment of pump and motor shaft.
 - 3. Impeller: ASTM B584 cast bronze, or stainless steel; statically and dynamically balanced, keyed to shaft and secured with a locking cap screw.
 - a. Where indicated on the pump schedule, trim impeller to match specified performance. This requires an initial flow/head reading with throttling valve 100% open. Contractor will provide this information to the pump factory, which will calculate the necessary impeller trim to achieve design flow within +10%/-0% without use of throttling valve. Contractor will remove impeller, provide trim, then reinstall impeller. Test & Balance contractor will then perform final balance.

- b. Where indicated on the pump schedule, pumps operating with variable frequency drive to be provided with largest size impeller for volute of pump. Ensure motor is capable of meeting BHP duty at RPM necessary to meet design flow/head. Modify pump selection or motor synchronous speed as necessary.
- 4. Pump Shaft: Stainless steel, or steel with stainless steel shaft sleeve.
- 5. Seal: Mechanical seal consisting of carbon rotating ring against a silicon carbide seat held by a stainless-steel spring. Provide with bellows and gasket made from materials suitable for the fluids and operating temperatures in the systems served. Include water slinger on shaft between motor and seal.
- 6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
- D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings are drop-out type to allow disassembly and removal without removing pump shaft or motor.
- E. Coupling Guard: Dual rated; ANSI B15.1, section 8; OSHA 1910.219 approved; steel, removable, attached to mounting frame.
- F. Mounting Frame: Welded steel frame and cross members, factory fabricated from channels and angles. Fabricate to mount pump casings, coupling guard, and motor.
- G. Motor: Single speed.
 - 1. 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. Comply with requirements for motors specified in Section 230529 – Basic Mechanical Materials and Methods.
 - 3. Shaft Grounding: Provide motor shaft grounding kit on all pumps operating with variable frequency drives with motors larger than 3 HP.
- H. Capacities and Characteristics: See schedule on drawings.

2.7 SEPARATELY COUPLED, BASE-MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

- A. Acceptable Manufacturers: Armstrong, Bell & Gossett, Grundfoss, Paco, Patterson, Taco, Weinman.
- B. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.
- C. Pump Construction:
 - 1. Casing: Radially or horizontally split, cast iron, with threaded gauge tapings at inlet and outlet, drain plug at bottom and air vent at top of volute, and ASME B16.1 Class 250 flanges. Casing supports allow removal and replacement of impeller without disconnecting piping. Maximum working pressure not less than 175 psig at continuous operating temperature not less than 225°F.

2. Impeller: ASTM B584 cast bronze, or stainless steel; statically and dynamically balanced, and keyed to shaft.
 - a. Where indicated on the pump schedule, trim impeller to match specified performance. This requires an initial flow/head reading with throttling valve 100% open. Contractor will provide this information to the pump factory, which will calculate the necessary impeller trim to achieve design flow within +10%/-0% without use of throttling valve. Contractor will remove impeller, provide trim, then reinstall impeller. Test & Balance contractor will then perform final balance.
 - b. Where indicated on the pump schedule, pumps operating with variable frequency drive to be provided with largest size impeller for volute of pump. Ensure motor is capable of meeting BHP duty at RPM necessary to meet design flow/head. Modify pump selection or motor synchronous speed as necessary.
 3. Pump Shaft: Stainless steel, or steel with stainless steel shaft sleeve.
 4. Seal: Mechanical seal consisting of carbon rotating ring against a silicon carbide seat held by a stainless-steel spring. Provide with bellows and gasket made from materials suitable for the fluids and operating temperatures in the systems served. Include water slinger on shaft between motor and seal.
 5. Pump Bearings: Permanently lubricated ball bearings, or grease-lubricated ball bearings in cast-iron housing with grease fittings.
- D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Coupling is drop-out type to allow disassembly and removal without removing pump shaft or motor.
- E. Coupling Guard: Dual rated; ANSI B15.1, Section 8 and OSHA 1910.219 approved; steel, removable, attached to mounting frame.
- F. Mounting Frame: Welded steel frame and cross members, factory fabricated from channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- G. Motor: Single speed.
 1. 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. Comply with requirements for motors specified in Section 230529 – Basic Mechanical Materials and Methods.
 3. Shaft Grounding: Provide motor shaft grounding kit on all pumps operating with variable frequency drives with motors larger than 3 HP.
- H. Capacities and Characteristics: See schedule on drawings.

2.8 VERTICAL TURBINE, MULTI-STAGE, CASING DIFFUSER PUMPS

- A. Acceptable Manufacturers: American Pumps, Bell & Gossett, Ebara, Flowserve, Grundfos, Taco.

- B. Description: Factory-assembled and -tested, multistage, centrifugal impellers inside diffuser casing, in-line pump as defined in HI 2.1-22 and HI 2.3, designed for installation with pump and motor shaft mounted vertically.
- C. Pump Construction:
 - 1. Pump Suction and Discharge Base: Cast iron or stainless steel, with ASME B16.1 Class 250 flange with threaded gauge tappings.
 - 2. Impeller: Stainless Steel; statically and dynamically balanced and keyed to shaft, with internal thrust balance in each stage.
 - 3. Diffuser Bowl: Each stage has a bowl with attached diffuser, constructed of stainless steel.
 - 4. Pump Shaft: Stainless steel.
 - 5. Pump Bearings: Water-lubricated silicon carbide or tungsten carbide shaft sleeves with ceramic bearings.
 - 6. Wear Rings: Stainless steel, provided within each stage, self-centering.
 - 7. Pump Casing/Outer Sleeve: Stainless steel with welded seams.
 - 8. Seal, Mechanical Type: Mechanical seal consisting of carbon rotating ring against a silicon carbide seat held by a stainless steel spring, and bellows and gasket made of materials appropriate for the fluid and operating temperatures of the system being served.
 - 9. Pump Thrust Compensation: External bearing flange located between the pump and motor, or drive motor fitted with angular contact bearings, designed to accommodate axial thrust during pump operation.
 - 10. Maximum working pressure not less than 360 psig, maximum working temperature not less than 240°F.
- D. Shaft Coupling: Keyed with locking collets. Design provides adequate space to remove and replace shaft seals without removal of pump components or piping. Provide with removable coupling guard.
- E. Motor: Single speed.
 - 1. 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. Comply with requirements for motors specified in Section 230529 – Basic Mechanical Materials and Methods.
 - 3. Shaft Grounding: Provide motor shaft grounding kit on all pumps operating with variable frequency drives with motors larger than 3 HP.
- F. Capacities and Characteristics: See schedule on drawings.

2.9 **FACTORY-PROVIDED VARIABLE FREQUENCY DRIVE WITH SENSORLESS SPEED CONTROL**

- A. Where scheduled, provide pump with variable frequency drive that complies with the requirements of specification section 230810 – Variable Frequency Drives. Drive it to be factory mounted to the pump motor frame and factory wired from the drive output terminals to the pump motor.

- B. Variable Frequency Drive to include integrated pump controller and software for sensorless control in variable-volume system without need for pump-mounted or remotely mounted differential pressure sensor.
 - 1. The controller includes the following user-selectable operating modes: operation under quadratic pressure control to ensure that head reduction with reducing flow conforms to quadratic control curve; constant pressure operating mode; conventional 230900 controls system speed modulation to satisfy a differential pressure setpoint measured at a remote DP sensor.
 - 2. Minimum head to be not more than 40% of design duty head.
 - 3. Provide user-adjustable control mode settings and minimum/maximum head set points using built-in user interface.
 - 4. Control pump performance for non-overloading power at all operating points.
 - 5. Controller is capable of maintaining flow rate data.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Equipment Mounting:
 - 6. Install all base-mounted pump and in-line pumps with motors greater than 3 HP on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03 "Concrete" and with specification section 230540 – Mechanical Sound and Vibration.
 - 7. Equipment Mounting: Install in-line pumps with motors 3 HP and smaller with continuous-thread hanger rods and spring hangers with vertical-limit stop of size required to support weight of in-line pumps.
 - 8. Comply with requirements for vibration isolation and seismic control devices specified in Section 230540 – Mechanical Sound and Vibration and 230548 - Mechanical Seismic Control.

3.3 ALIGNMENT

- A. Engage a factory-authorized service representative to perform alignment service.
- B. Perform alignment service. When required by manufacturer to maintain warranty coverage, engage a factory-authorized service representative to perform it.
- C. Comply with requirements in HI standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- D. Comply with pump and coupling manufacturers' written instructions.
- E. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 PIPING CONNECTIONS

- A. Comply with requirements in specification section 232113 – HVAC Piping and Specialties. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to pump, allow space for service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as pipes leading to/from pumps. Provide reducers as necessary to connect pipes to pumps.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping. Use startup strainer for initial startup.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in correct direction.
 - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 6. Start motor.
 - 7. Open discharge valve slowly.
 - 8. Sensorless Speed Controller Setup: Input setpoints for proper operation of sensorless speed control feature. Work with Test & Balance and Temperature Controls contractors to determine necessary setpoints, record final setpoints in O&M manuals.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Hydronic pumps will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 232123

**SECTION 232500
HVAC WATER TREATMENT**

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Pre-Startup cleaning of HVAC Piping Systems.
- B. Pre-Startup cleaning of Boilers Piping Systems.
- C. Chemical Feeders.
- D. Treatment for Closed Systems:
 - 1. Heating Water
 - 2. Chilled Water

1.2 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish only the following items to Section 232113 - HVAC Piping Contractor for installation:
 - Manifolds
 - Solenoid Water Valves with Strainers
 - Pot Feeders
 - Motorized Ball Valves for solids separator blowdown/bleed

1.3 RELATED WORK

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.
- B. Section 230500 - Basic Mechanical Requirements.
- C. Section 230529 - Basic Mechanical Materials and Methods.
- D. Section 230548 – Mechanical Seismic Control
- E. Section 221411 - Disinfecting Water Supply System.
- F. Section 232113 - HVAC Piping and Specialties.
- G. Section 236400 – Refrigeration.

1.4 QUALITY ASSURANCE

- A. All products shall be provided by a single Contractor to ensure there being a single source of responsibility.
- B. Water Treatment, Chemical and Service Suppliers approved for this project are as follows:
 - 3. Power Engineering Company
 - 4. WEST, Inc.
 - 5. Alpine Technical Services
 - 6. Nalco

1.5 SUBMITTALS

- A. Water Analysis: Illustrate water quality available at project site.
- B. Technical Data: Submit Shop Drawings and Product Data for the following items in accordance with the General Conditions of the Contract:
 - 1. Water Treatment Materials and Equipment.
 - 2. Control Diagrams.
 - 3. Chemicals and quantity provided.
- C. Operating Instructions and Maintenance Data: Submit printed Operating Instructions and Maintenance Data for the following items in accordance with Operating and Maintenance Data Paragraph in Section 230500.
 - 1. All Water Treatment Equipment and Procedures.
 - 2. Water Treatment Program Control Chart.
 - 3. System start-up report.

1.6 MAINTENANCE SERVICE

- A. Provide the services of a fully qualified Field Engineer and laboratory and technical assistance from a fully qualified laboratory staff for one year warranty period. Services and assistance shall include the following:
 - 1. A two hour training course for the Owner's operating personnel instructing them clearly and fully on the installation, care, maintenance, testing, and operation of the water treatment systems. The training course shall be arranged by the Division 23 Contractor at the startup of the system.
 - 2. A bi-annual technical service visit to the jobsite of the installation to perform field inspections and to make water analysis on site, both of such complexity as to evaluate the water systems operations. The Field Engineer shall detail findings with the proper personnel in writing on proper practices, chemical treating requirements, and any corrective actions needed to protect the water systems from scale, corrosion, and fouling. Two copies of the written field service report shall be forwarded to the Owner after each visit.

3. Be on call at no additional cost increase to the Contract Sum to make on-site inspections of equipment during scheduled or emergency outages in order to properly evaluate the success of the water treatment program, and to make recommendations in writing based upon these inspections.

1.7 EXTRA STOCK

- A. Provide sufficient chemicals for treatment and testing during one year warranty period. If any system loses the chemicals due to pipe leaks or any other system malfunction, the Contractor shall replace the chemicals at no expense to the Owner. Chemicals shall not be harmful to the system in which they are used, and shall comply with Jurisdictional Codes governing the use and discharge of chemical formulations.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
- B. Base HVAC water treatment on quality of water available at project site.
- C. All cleaners and chemicals shall be compatible with the piping system components and connected equipment in the systems in which they are used. Contractor shall review all pipe, pipe components, pipe specialties, and connected equipment materials (steel, cast iron, copper, stainless steel, aluminum, etc.) that the contractor will provide for this project, then select cleaners and chemicals recommended by the water treatment system manufacturer that are compatible with these materials.

2.2 PRE-STARTUP CLEANER

- A. Provide a pre-startup liquid alkaline dispersant cleaner for the flushing and cleaning of all HVAC water and Glycol systems to remove oil and foreign matter from the piping and equipment prior to the final filling of the systems. This chemical shall not be injurious to persons, piping, pipe joint compounds, packings, coils, valves, pumps, and their mechanical seals, tubes or other parts of the system.
- B. Provide a pre-startup liquid alkaline dispersant cleaner for the flushing and cleaning of the steam boilers and related equipment to remove oil and foreign matter from the equipment prior to startup.
- C. Furnish complete instructions dictating the quantities of the cleaner to use, methods, and duration of the operation.

2.3 STARTUP CLEANING OF STEAM PIPING SYSTEM

- A. Provide chemicals for startup cleaning of steam and condensate piping systems. Assist installing contractor and boiler startup technician during boiler startup to conduct once-through cleaning of piping systems.

2.4 CHEMICAL FEED EQUIPMENT FOR CLOSED SYSTEMS

- A. Provide pot feeders for the following closed systems:
 - 1. Heating Water
 - 2. Chilled Water
- B. Feeder shall be bypass Pot Feeder of sufficient capacity with 3/4" brass drain valve. All feeders shall be able to withstand a maximum working pressure of 175 psi.

2.5 CLOSED SYSTEM WATER TREATMENT CHEMICALS

- A. Provide liquid borate nitrite corrosion inhibitor plus an azole inhibitor treatment for the prevention of corrosion in closed systems at 700 PPM total nitrite level.
- B. Note that some systems contain glycol provided under HVAC Piping Section 232113.

2.6 WATER TREATMENT CONTROL TESTING EQUIPMENT

- A. Provide testing chemicals to properly analyze the condenser water for organic phosphonate and closed system water for nitrite. Furnish the necessary test kits for these tests.
- B. Provide a Myron L "DS" meter, single range, 0-5000 MICROMHOS/CM auto-temp compensation 50-160 deg.F, 9-volt transistor batteries, and built in cell cup.
- C. Furnish a supply of log sheets on which to record the test results and bound copy of full test instructions.
- D. Provide test kit for measuring the concentration of propylene glycol solutions, test instrument shall be of refractive index type with two-point calibration.

PART 3 EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at project site.

3.2 INSTALLATION

- A. Coordinate where installation of equipment in piping systems is required with the Section 232113 - HVAC Piping and Electrical requirements per Section 230529 - Basic Mechanical Materials and Methods and provide installation instructions to installing personnel as necessary

3.3 CLEANING OF PIPING SYSTEMS

- A. Thoroughly clean the HVAC water and Glycol piping systems after hydrostatic tests have been completed and prior to the operating tests with liquid alkaline dispersant cleaner per instructions specified in Part 2 dictating the quantities of the cleaner to use, methods, and duration of the operation. Systems shall then be drained and thoroughly flushed out with fresh water.
- B. Contractor shall notify Architect/Engineer prior to cleaning operation, and shall verify in writing to the Architect/Engineer after the system has been cleaned.
- C. Failure of any part of the system due to improper cleaning or inadequate chemical feed shall be the responsibility of the Division 23 Contractor.
- D. Contractor is to provide bypasses and isolation valves as required to allow circulation of cleaning solution in new piping system without allowing system cleaning solution to circulate through existing piping system. Coordinate proper bypass and isolation valve locations with all trades to ensure proper cleaning of entire new HVAC piping systems.
- E. Water used for the initial fill and make-up water supply for the heating water system shall have hardness levels between 5 and 12 grains per gallon, pH between 6.5 and 8.5, and TDS less than 350 ppm.

3.4 SYSTEM START-UP

- A. Put the treatment equipment into operation and make adjustments necessary for proper operation.
- B. Provide a written report to the Owner and Architect indicating that the start-up has been completed and that all equipment is operating properly.

3.5 OPERATOR TRAINING AND SERVICE

- A. Instruct the Owner's operating personnel so as to familiarize them with all treatment equipment and procedures per Maintenance Service specified in Part 1 of this Section. Minimum of 2 hours/system type.
- B. Obtain a signed receipt from the Owner's operating personnel to confirm that adequate training has been received to operate the systems properly.

END OF SECTION 232500

**SECTION 233300
DUCTWORK AND ACCESSORIES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Low pressure ductwork.
- B. Medium and high pressure ductwork.
- C. Manufactured duct joints.
- D. Casings.
- E. Damper operator hardware.
- F. Volume control dampers.
- G. Fire dampers.
- H. Combination fire and smoke dampers.
- I. Combination fire, smoke, and control dampers.
- J. Smoke dampers.
- K. Gravity backdraft dampers.
- L. Motorized pressure dampers.
- M. Motorized backdraft dampers.
- N. Insulated flexible round ductwork.
- O. Flexible duct fan connections.
- P. Access door hardware.
- Q. Duct access doors.

1.2 PRODUCTS INSTALLED BUT NOT FURNISHED IN THIS SECTION

- A. Outside, return, and exhaust air dampers for supply fan/return fan systems per Section 230900.
- B. Airflow measuring devices per Section 230900.

1.3 RELATED REQUIREMENTS

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.
- B. Section 230500 - Basic Mechanical Requirements.

1.4 RELATED SECTIONS

- A. Section 230529 - Basic Mechanical Material and Methods.
- B. Section 230540 - Mechanical, Sound and Vibration Control.
- C. Section 230548 – Mechanical Seismic Control.
- D. Section 230593 - Testing, Adjusting and Balancing.
- E. Section 230700 - Mechanical Insulation.
- F. Section 230900 - Electronic Controls.

1.5 REFERENCES AND CODE REQUIREMENTS

- A. ASHRAE - Handbook Fundamentals; Duct Design Chapter.
- B. ASHRAE - Handbook HVAC Systems and Equipment; Duct Construction Chapter.
- C. ASTM A90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
- D. ASTM A480 – Standard Specification for General Requirements for flat-rolled stainless and heat-resisting steel plate, sheet, and strip.
- E. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dipped Process.
- F. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate.
- G. ASTM C14 - Concrete Sewer, Storm Drain, and Culvert Pipe.
- H. ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- I. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- J. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
NFPA 92A - Smoke Control Systems.
NFPA 92B - Smoke Management Systems.
- K. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.
- L. SCAQMD Rule 1168 – Adhesive and Sealant Applications

- M. SMACNA - HVAC Duct Construction Standards.
- N. SMACNA - HVAC Air Duct Leakage Test Manual
- O. SMACNA - Fibrous Glass Duct Construction Standards.
- P. UL 33 - Heat Responsive Links for Fire-Protection Service.
- Q. UL 181 - Factory-Made Air Ducts and Connectors.
- R. UL 555 - Fire Dampers and Ceiling Dampers.
UL 555S - Leakage Rated Dampers for Smoke Control Systems.

1.6 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.
- B. Low Pressure: Design and Construct to SMACNA 2 in. w.g. pressure class. Low pressure duct shall include: Supply duct downstream of VAV boxes, return duct, general/toilet exhaust ducts, fresh air duct, relief duct, smoke exhaust duct and combustion air duct, unless otherwise indicated on drawings.
- C. Medium Pressure: Design and Construct to SMACNA 6 in. w.g. pressure class. Medium pressure duct shall include: Supply duct from supply fan(s) to VAV box inlets including built-up plenums where applicable.

1.7 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A standards.

1.8 SUBMITTALS

- A. Submit Shop Drawings for the following items under provision of The General Conditions of the Contract:
 - 1. Shop fabricated assemblies including duct or plenum access doors.
 - 2. Duct fittings, particulars such as gauges, sizes, weld, and configuration prior to start of work for low pressure systems.
- B. Submit Product Data for the following items under provision of The General Conditions of the Contract:
 - 1. Combination fire and smoke dampers.
 - 2. Backdraft dampers.

- C. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:
 - 1. Combination Fire and Smoke Dampers.

1.9 PROJECT CONDITIONS

- A. Do not fabricate or install any ductwork until Contractor has confirmed that the ductwork can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.
- B. Prepare 1/4" = 1'-0" scale shop drawings of all ductwork and plenums that are part of this project for coordination with other trades and the Architectural and structural work.
- C. Provide any and all off-sets and fittings required to coordinate with field conditions. The lack of coordination will not constitute a change in contract price. The contract drawings are of a schematic nature only, exact duct routing and field coordination is the responsibility of the Contractor.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Nonmetallic air ducts and connectors shall conform to UL 181 Class 0 or Class 1.
- B. Steel Ducts: ASTM A653 galvanized steel sheet, lock-forming quality, having G90 zinc coating each side in conformance with ASTM A90.
- C. Aluminum Ducts: ANSI/ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.
- D. Fasteners: Rivets, bolts, or sheet metal screws.
- E. Sealant: Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape, or heavy mastic, and comply with the chemical content requirements of SCAQMD Rule 1168.

2.2 LOW PRESSURE DUCTWORK

- A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures specified or as indicated on drawings.
- B. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide turning vanes.
- C. Construct fittings with 45-degree wye or 90 degree wye with 45 degree entry.

- D. Round branch connections shall be plain flanged or spin collar fittings of 90 degrees unless indicated otherwise on drawings. Round branch connections fittings serving low-pressure duct run-outs to diffusers and grilles shall include damper blade with two quadrants, fully retractable zinc alloy bearings, washers, and position handle with wing nut to lock damper position. Where used on externally insulated ducts, provide with single quadrant installed on 2" standoff bracket plate with position handle and wing nut to lock damper position.
1. Provide remote operated damper where round branch duct and fitting is not accessible.
 - a. Manually operated, gear driven cable operated damper with manual HEX head actuator, cable mounting bracket, white cover plate where installed in ceiling, and cable.
 - b. Electronic, with factory installed 9 volt DC motor and low-voltage, plenum rated cable that terminates with standard connector. A hand-held device contains the 9 volt battery and plugs into the standard end-of-cable connector to rotate damper blade to adjust airflow. Cables to terminate in a j-box with the end-of-cable connectors secured in a face plate that accommodates up to twelve end-of-cable and includes labels that identify the balance damper served by each cable. Provide two hand-held devices for the project. Acceptable manufacturers include Greenheck, Pottorff, Price Industries, M.A.P/Metropolitan Air Technology, Ruskin, Young Regulator, Zip Group.
- E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
- F. Provide easements where low pressure ductwork conflicts with piping and structure. Where easements exceed 10 percent duct area, split into two ducts maintaining original duct area.
- G. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of airflow.

2.3 MEDIUM PRESSURE DUCTWORK

- A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards and ASHRAE handbooks. Provide duct material, gauges, reinforcing, and sealing for operating pressures specified or as indicated on drawings.
- B. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline.
- C. Where space constraints do not allow a centerline radius of 1-1/2 times width, All rectangular smooth radius elbows shall be SMACNA type RE3 with two full length splitter vanes, in accordance with Figure 4-2 of the SMACNA HVAC Duct Construction Standards. Radius can be of any value between 0.75 to 1 times width of duct on centerline. Attach vanes to duct wall by welding, do not use rivets or bolts. Spacing for both splitter vanes is in accordance with paragraph 5.15 Splitter Vanes in the SMACNA HVAC System Duct Design manual.

- D. Provide conical fittings constructed to conform to details of the Sheet Metal and Air Conditioning Contractors National Association Manual (SMACNA) in branch ducts of medium pressure take-offs to VAV boxes.
- E. Transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence
- F. Double-Wall Duct: Construct inner wall of 22 gauge galvanized steel, perforated with 3/32 inch diameter holes on 3/16 inch staggered centers, minimum 23% open area. Interstitial insulation shall be mineral wool, 2 inch thick, density not less than 6.0 lb cubic foot, thermal resistance not less than R-8.6, that complies with NFPA 90A. Provide sheet metal edges/end caps at ends of ductwork sections and fittings to totally contain edges of insulation. Construct in accordance with the double-wall duct construction chapter of the SMACNA HVAC Duct Construction Standards.

2.4 DUCT SUPPORTS

- A. Hanger Rods: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- B. Hanger Straps for Galvanized Steel Duct: Galvanized steel.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- E. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.5 MANUFACTURED DUCT JOINTS

- A. Manufacturer: Ductmate Industries, Inc., TDF, MEZ Industries, Hercules.
- B. Transverse duct joints of medium pressure ductwork shall be made with the Ductmate System components of standard catalog manufacture.

2.6 CASINGS

- A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards for 2-inwg pressure class of not less than 18 gauge panels, unless otherwise indicated on drawings.
- B. At floor, rivet or bolt panels on 8 inch centers to angles bolted to 6" wide x 4" tall concrete curb.

- C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position. Provide a 12" x 12" wire glass viewing port in each door with center at 4'-6" A.F.F.
- D. Fabricate acoustic casings with reinforcing turned inward. Provide 16 gauge back facing in supply fan sections and elsewhere if indicated on drawings. Provide 22 gauge perforated front facing with 3/32 inch diameter holes on 3/16 inch staggered centers with 23% free area. Construct panels 2 and 4 inches thick as indicated on the drawings, packed with 4.5 lb/cu. ft. minimum mineral wool media, on inverted channels of 16 gauge.

2.7 DAMPER OPERATOR HARDWARE

- A. Manufacturers: Ventfabrics Ventlok Regulators, Metropolitan Air.
- B. Other acceptable manufacturers offering equivalent product: Duro Dyne, Daniel.
- C. Regulators and End Bearings.

Damper shaft length:
12" or less - Ventlok #620 Regulator.
12" to 20" - Ventlok #635 Regulator and #607 Bearings.
Larger dampers - Ventlok #640 or #641 Regulator and #607 Bearings.
- D. Provide equivalent model elevated bases for insulated ducts.
- E. Provide remote damper control where any damper does not have permanent access. System to include a locking worm drive gear, 1/4" flexible steel shaft and a concealed ceiling cap of 1". Manufacturers: Young Regulator, Price, or approved equal.

2.8 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.
- B. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inch.
- C. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 6 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, polymer or sintered bronze bearings.
- E. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
- F. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
- G. Specification for low-pressure spin collar fittings with integral balancing dampers is found in paragraph 2.2.

2.9 FIRE DAMPERS FOR STATIC SYSTEMS (NON HIGH-RISE BUILDINGS)
(All building supply and exhaust fans shut down upon fire and/or smoke alarm)

- A. Acceptable manufacturers: Meet UL-555 requirements.
- B. Furnish and install, where plans show square or rectangular fire wall penetrations, fire dampers constructed and tested in accordance with the current edition of UL-555, Standard For Fire Dampers. Each fire damper shall be marked with a UL classified 1-1/2 hour fire protection rating and "for use in static systems only." In addition each fire damper shall include a 165°F fusible link. Fire dampers shall have damper blades out of air stream for minimum airflow restriction. Fire dampers shall include a factory fabricated steel sleeve with 12" or 22" two piece picture frame mounting angles factory supplied and shipped on each damper to ensure appropriate installation. Submittal information shall include the fire protection rating and the manufacturer's UL installation instructions. The dampers shall be installed in accordance with manufacturer's instructions shipped with the damper. Fire dampers shall be equivalent to Ruskin model IBD2 "B" Style.
- C. Where plans show round or oval fire wall penetrations, furnish and install fire dampers as described above except that fire damper shall have damper frame and blades completely out of air stream for minimum air flow restriction. Damper shall include a factory fabricated fully welded and sealed steel sleeve with 12" or 22" two piece picture frame mounting angles factory supplied and shipped on each damper to ensure appropriate installation. Submittal information shall include the fire protection rating and the manufacturer's UL installation instructions. The dampers shall be installed in accordance with these instructions. Fire dampers shall be equivalent to Ruskin model IBD2 "CR" or "CO" Style.
- D. Ducts connecting to sleeves shall be equal to or less than the sleeve thickness. Sleeve gauge requirements are listed in the SMACNA Fire, Smoke and Radiation Damper Installation Guide and outlined in NFPA 90A. If any other duct to sleeve connections are used, sleeve shall be 16 ga. minimum for dampers up 36"x24", and 14 ga. if damper width exceeds 36" or damper height exceeds 24".
- E. Where job conditions require vertical dampers larger than manufacturer's maximum UL tested sizes, contractor will provide and install fire rated mullions in accordance with fire damper manufacturer's instructions.
- F. Where duct gauges allow their use, contractor may, at his option, install square or rectangular fire dampers with 12, 14, 16" long integral roll-formed steel sleeves. Retaining angles shall be furnished by the damper manufacturer to ensure appropriate installation. Submittal information shall include the fire protection rating and the manufacturer's UL installation instructions. Each fire damper shipment shall include the same UL installation instructions and the dampers shall be installed in accordance with these instructions. Fire dampers shall be Ruskin model IBD20, IBD40, or IBD60 "B" Style. Where round or oval duct gauges allow their use, contractor may, at his option, install round or oval fire dampers with 12, 14, 16" long integral roll-formed steel sleeves. Installation shall be as described above. Sleeves shall be factory sealed airtight. Fire dampers shall be equivalent to Ruskin model IBD20, IBD40, or IBD60 Style "LR" or "LO."

- G. Contractor may, with engineer's approval, use certain models of dampers that afford ease of installation and labor savings such as dampers designed for grills, dampers with S-and-Drivemate breakaway connections, or dampers designed for metal stud wall applications. Install as described above per the manufacturer's UL installation instructions.

**2.10 SMOKE DAMPERS FOR STATIC SYSTEMS (NON HIGH-RISE BUILDINGS)
(All building supply and exhaust fans shut down upon fire and/or smoke alarm)**

- A. Acceptable manufacturers: Meet UL 555S requirements.
- B. Furnish and install at locations shown on plans, or as described in schedules, Ruskin model SD-60 or equivalent smoke dampers meeting or exceeding the following specifications. Frame shall be a minimum of 16 gauge galvanized steel formed into a structural hat channel reinforced at corners for added strength. The blades shall be airfoil shaped double skin construction with 14 gauge equivalent thickness. Non-airfoil blade shapes are not allowed. Blade action shall be opposed. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Galvanized or synthetic bearings are not acceptable. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked into blade edge and shall withstand a minimum of 450°F. Adhesive or clip fastened seals are not acceptable. Jamb seals shall be non-corrosive stainless steel flexible metal compression type.
- C. Each smoke damper shall be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems in accordance with the latest version of UL555S, and bear a UL label attesting to the same. Damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be leakage Class I (4 cfm/sq. ft. at 1" w.g. and 8 cfm/sq. ft. at 4" w.g.). As part of the UL qualification, dampers shall have demonstrated a capacity to operate (to open and close) under HVAC system operating conditions, with pressures of at least 4" w.g. in the closed position, and up to 4,000 fpm air velocity in the open position.
- D. Each smoke damper shall be equipped with a factory supplied and mounted 24v electric actuator to close the smoke damper during test, smoke detection, power failure.

2.11 CORRIDOR FIRE/SMOKE DAMPERS

- A. Acceptable manufacturers: Meet UL requirements for a "Corridor Damper."
- B. Where tunnel corridor penetrations are square or rectangular, furnish and install at locations shown on the plans or as described in schedules, corridor dampers meeting or exceeding the following specification:

- C. Frame shall be a minimum of 16 gauge galvanized steel formed into a structural hat channel and shall be low profile high performance type for lowest pressure drop. The blades shall be single skin galvanized steel 16 gauge minimum with three longitudinal grooves for reinforcement. Bearings shall be stainless steel turning in an extruded hole in frame. (Galvanized or synthetic bearings shall not be acceptable.) Blade edge seals shall be inflatable silicone coated fiberglass material to insure tight seal and low leakage. Seals shall be mechanically locked into blade edge (adhesive or clip fastened seals not acceptable) and shall withstand a minimum of 450°F. Jamb seals shall be non-corrosive stainless steel flexible metal compression type.
- D. Each damper shall be listed as a fire damper and leakage (smoke) damper and classified by Underwriters Laboratories as a "Corridor Damper" for installation in tunnel corridors. They shall be rated for 1 hour fire resistance under UL555 and shall have a minimum leakage rating of Class II under UL555S for use in smoke control systems. Each damper shall bear a UL label designating the damper as "Corridor Damper."
- E. In addition to the leakage ratings already specified herein, the dampers and their non-stall type actuators shall be qualified under UL555S to an elevated temperature of 350°F. Appropriate 24 v electric actuators shall be installed by the damper manufacturer at time of damper fabrication. Stall type and instantaneous close type actuators not acceptable. Damper and actuator shall be supplied as a single entity meeting all applicable UL555 and UL555S qualifications for both dampers and actuators.
- F. Damper manufacturer shall provide factory assembled minimum 20 gauge steel sleeve. Damper shall be sealed to the sleeve with a 25/50 flame spread/smoke developed sealant material.
- G. Each corridor damper shall be equipped with a controlled 7 to 15 second heat-actuated release device. The electric EFL shall close and lock the fire/smoke damper during test, smoke detection, power failure or fire conditions through actuator closure springs. To prevent duct and HVAC component damage, the damper shall at all times be connected to the actuator for controlled closure in not less than 7 seconds and no more than 15 seconds. Instantaneous damper closure is unacceptable. Damper shall be automatic remote resettable after test, smoke detection or power failure conditions. After exposure to high temperature or fire, the damper must be inspected prior to reset to ensure proper operation. Release temperatures are 165°F. 1 hour dampers shall be Ruskin model FSD36C or equivalent.
- H. Where tunnel corridors use round neck diffusers, furnish and install round combination fire/smoke dampers for ceiling penetration of tunnel corridors complete with integral surface mounted ceiling diffusers, Ruskin model DFSDR or equivalent. Operation shall be the same as described above.

**2.12 FIRE/SMOKE DAMPERS FOR STATIC SYSTEMS (NON HIGH-RISE BUILDINGS)
(All building supply and exhaust fans shut down upon fire and/or smoke alarm)**

- A. Acceptable manufacturers: Meet UL-555S requirements.

- B. Furnish and install at locations shown on plans, or as described in schedules, combination fire/smoke dampers meeting or exceeding the following specifications. Frame shall be a minimum of 16 gauge galvanized steel formed into a structural hat channel reinforced at corners for added strength. The blades shall be airfoil shaped double skin construction with 14 gauge equivalent thickness. Non-airfoil blade shapes are not allowed. Blade action shall be opposed. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Galvanized or synthetic bearings are not acceptable. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked into blade edge and shall withstand a minimum of 450°F. Adhesive or clip fastened seals are not acceptable. Jamb seals shall be non-corrosive stainless steel flexible metal compression type.
- C. Each combination fire/smoke damper shall be classified 1-1/2 hour for use in fire resistance ratings of less than 3 hours or 3 hour for use for fire resistance ratings of 3 hours or more. They shall be in accordance with UL standard 555, and shall further be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems in accordance with the latest version of UL555S, and bear a UL label attesting to the same. Damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be leakage Class I (4 cfm/sq. ft. at 1" w.g. and 8 cfm/sq. ft. at 4" w.g.). As part of the UL qualification, dampers shall have demonstrated a capacity to operate (to open and close) under HVAC system operating conditions, with pressures of at least 4" w.g. in the closed position, and up to 4,000 fpm air velocity in the open position.
- D. In addition to the leakage ratings already specified herein, the dampers and their non-stall type actuators shall be qualified under UL555S to an elevated temperature of 350°F. Appropriate 24v electric actuators shall be installed by the damper manufacturer at time of damper fabrication. Stall type and instantaneous close type actuators not acceptable. Damper and actuator shall be supplied as a single entity meeting all applicable UL555 and UL555S qualifications for both dampers and actuators. Manufacturer shall provide factory assembled sleeve of at least 17" long (contractor to verify maximum requirement). Factory supplied caulked sleeve shall be 20 gauge for dampers through 84" wide and 18 gauge for dampers above 84" wide. 12" or 22" single piece picture frame mounting angles shall be factory supplied and shipped on each damper/sleeve assembly. Factory shall supply sleeves to accommodate square, rectangular, round, or oval ducts.
- E. Each combination fire/smoke damper shall be equipped with a controlled 7 to 15 second heat-actuated release device. The electric EFL shall close and lock the fire/smoke damper during test, smoke detection, power failure or fire conditions through actuator closure springs. To prevent duct and HVAC component damage, the damper shall at all times be connected to the actuator for controlled closure in not less than 7 seconds and no more than 15 seconds. Instantaneous damper closure is unacceptable. Damper shall be manually resettable after activation by heat and after exposure to high temperature or fire, the damper must be inspected prior to reset to ensure proper operation. Release temperatures are 165°F. 1-1/2 hour dampers shall be Ruskin model FSD60 or equivalent and 3 hour dampers shall be Ruskin model FSD60-3 or equivalent.

2.13 GRAVITY BACKDRAFT DAMPERS (LOW VELOCITY COUNTERBALANCE TYPE) (< 2.0" w.c.)

- A. Acceptable Manufacturers: Air Balance, American Warming, Arrow United (Type 655), Louvers and Dampers Inc., Prefco, Ruskin (CBD4 or CBD6), C.E. Sparrow, Airstream, Greenheck, Pottorff.
- B. Gravity backdraft dampers, size 18 x 18 inches or smaller, furnished with air moving equipment, may be air moving equipment manufacturers standard construction.
- C. Fabricate multi-blade, parallel action gravity balanced backdraft dampers of 16 gauge galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.14 BACKDRAFT DAMPERS (HIGH PRESSURE COUNTERBALANCE TYPE) (> 2.0" w.c.)

- A. Manufacturer: Arrow United Industries Arrow-Foil Type 800, Greenheck, Ruskin, Pottorff.
- B. Extra heavy duty design with air foil extruded aluminum blades with 12 gauge walls, reinforcing struts, double seal type bearings on asymmetrically placed axles with linkage out of the air stream.
- C. Dampers engineered for minimum air leakage at high static pressure by means of overlapping design and extruded vinyl seals on blades and jambs.
- D. Counterweights located externally on extended shaft, adjustable to assist or resist opening at infinite pressure increments.
- E. Dampers shall be furnished for horizontal airflow.

2.15 INSULATED FLEXIBLE ROUND DUCTWORK

- A. Manufacturer: Flexmaster Type 5B - Insulated.
- B. Other acceptable manufacturers offering equivalent product subject to compliance with specified requirements: Genflex, Thermaflex, Wiremold, Cleva-Flex, H.K. Porter Co., Cal-Flex, Hart & Cooley, Hercules, Quietflex.
- C. Insulated low pressure flexible duct factory fabricated assembly consisting of a polyester coated fiberglass fabric mechanically interlocked by a galvanized steel spiral helix wrapped with minimum R=6 fiberglass insulation sheathed in a vapor barrier jacket. Vapor barrier permeance ≤ 0.10 perm, per ASTM E96.
- D. Composite assembly, including insulation and vapor barrier shall be UL Listed 181 for Class 1 Air Duct Material and comply with NFPA Standard 90A.

2.16 FLEXIBLE DUCT FAN CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.
- B. Indoor: UL listed fire-resistant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz. per sq. yd., minimum 4-inch wide, crimped into metal edging strip.
- C. Outdoor: UL listed hypalon coated woven glass fabric to NFPA 90A, minimum density 24 oz. per sq. yd., minimum 4-inch wide, crimped into metal edging strip.
- D. Leaded vinyl sheet, minimum 0.55 inch thick, 0.87 lbs, per sq. ft., 10 dB attenuation in 10 to 10,000 Hz range.

2.17 ACCESS DOOR HARDWARE

- A. Manufacturer: Ventfabrics Ventlok Series
- B. Other acceptable manufacturers offering equivalent product: Duro Dyne.
- C. Latches, hinges and gasketing:
 - Doors less than 4 square feet - Series 100.
 - Doors 4 to 8 square feet - Series 200.
 - Larger doors and in medium pressure systems - Series 300.

2.18 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards as indicated.
- B. Review locations prior to fabrication.
- C. Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
- D. Access doors smaller than 12 inches square may be secured with sash locks.
- E. Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.
- F. Access doors with sheet metal screw fasteners are not acceptable.
- G. Provide observation window in all access doors installed at control dampers, fire dampers, smoke dampers, and combination fire/smoke dampers so damper blade position can be observed through the window.

PART 3 EXECUTION

3.1 GENERAL SHEET METAL INSTALLATION

- A. Duct sizes fall within the limiting dimensions indicated on the Drawings. Provide sheet metal duct systems, connections, dampers, duct turns, housings, hinged sheet metal doors and necessary removable access doors for the complete supply, return, and exhaust systems. Install accessories in accordance with manufacturer's instructions.
- B. Wherever exposed ducts pass through walls, floors, or ceilings, a 2-inch flanged sheet-metal collar fitting close around ducts to be slipped along duct until flange is tight against finished surface covering edges of openings and presenting a neat appearance. Lock collar to duct.
- C. Wherever ducts penetrate floors or fire walls, install safining insulation to maintain fire wall integrity.
- D. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps. Permanent test holes shall be factory fabricated, airtight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.
- E. Provide openings in ductwork where required to accommodate thermometers and controllers.
- F. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- G. Where Bellmouth fittings are specifically called for on Drawings, provide standard Bellmouth fittings per SMACNA Standards.
- H. On smoke management system ducts, conduct a leakage test, per Chapter 9 of the 2009 IBC, to 1.5 times the design pressure. Total leakage shall not exceed 5% of design flow.
- I. Wherever dampers are concealed under insulation, provide marker ribbon for identification. Hang ribbon below adjacent ductwork to allow view from any angle.
- J. Requirements for duct liner are located in Specification Section 230540 – Mechanical Sound and Vibration Control.

3.2 MEDIUM AND HIGH PRESSURE DUCTWORK (greater than 2" w.c.)

- A. Use radius elbows with centerline radius of 1.5D (or 1.5W for rectangular) for all turns in medium pressure ductwork. Obtain Engineer's approval for reducing the centerline radius at specific locations where a centerline radius of 1.5 cannot be provided because of conflict with building structure or other utilities. Note approval may not be given if other solutions are possible.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 SEALING OF DUCTWORK

- A. Seal all ductwork to Seal Class A as defined in the SMACNA HVAC Duct Construction Standards and as required by the International Energy Conservation Code. Additional sealing will be required if audible air leaks are observed. Where joints are not accessible for proper sealing, cut hand holes in duct and seal the joints from the inside.

3.5 DUCT LEAKAGE TESTING

- A. Conduct a complete duct leakage test of all medium pressure supply air mains and vertical risers as outlined in the most current edition of the SMACNA Air Duct Leakage Test Manual. Unless specifically noted otherwise on Drawings, testing for medium pressure ductwork is defined as Leakage Class 4 for rectangular ductwork and Leakage Class 2 for round or flat oval ductwork.

- B. Total leakage of each duct system not to exceed recommendations in SMACNA Air Duct Leakage Test Manual per Leakage Classifications defined above. If leakage rate exceeds maximum allowed, reseal ductwork until measured system leakage rate is less than the maximum allowable leakage rate.
- C. Test all medium pressure ductwork 2" wc positive pressure and extrapolate values out to 6" wc positive pressure. Provide all necessary blank-offs to perform test.
- D. Perform a leakage test on all field erected air handler casings from the outdoor/return air dampers through to the point the medium pressure duct connects to the discharge opening at the end of the air handler. Leakage shall be limited to 1% of design flow. Test casing to 2" wc positive pressure, and extrapolate values out to 6" wc positive pressure. Provide all necessary blank-offs.

3.6 MANUFACTURED DUCT JOINTS

- A. The installation of the manufactured duct joints shall be in accordance with the manufacturer's printed instruction and installation manuals. Apply multiple thicknesses of folded butyl gasket material at each corner of rectangular duct joints to assure air tightness.

3.7 DUCTWORK APPLICATION SCHEDULE

A. AIR SYSTEM MATERIAL

Low Pressure Supply (Heating Systems)	Galvanized Steel
Low Pressure Supply (System with cooling coils)	Galvanized Steel
Medium and High Pressure Supply	Galvanized Steel
Return and Relief	Galvanized Steel
General Exhaust	Galvanized Steel
Low Pressure Flex Duct	Insulated Flexible Round Duct
Outside Air Intake	Galvanized Steel
Combustion Air	Galvanized Steel

3.8 DAMPER OPERATOR HARDWARE

- A. Install per manufacturer's instructions and recommendations. Coordinate any ceiling control locations prior to installation.
- B. Coordinate length of flexible shaft on site.

3.9 VOLUME CONTROL DAMPERS

- A. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing.

3.10 FIRE DAMPERS, SMOKE DAMPERS AND COMBINATION FIRE/SMOKE DAMPERS

- A. Provide fire dampers, combination fire and smoke dampers or smoke dampers at locations indicated, where ducts and outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges per manufacturer's instructions.
- B. Demonstrate re-setting of fire/smoke dampers and/or smoke dampers to authorities having jurisdiction and Owner's representative.

3.11 GRAVITY BACKDRAFT DAMPERS (LOW PRESSURE SYSTEMS)

- A. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside of building and where indicated.
- B. Provide counter-balanced gravity backdraft dampers in return air duct sections from CRAC units to ceiling plenums to prevent air bypass from raised floor to ceiling space when CRAC unit fan is "off".

3.12 MOTORIZED BACKDRAFT DAMPERS

- A. Provide motorized backdraft dampers where shown on drawings.

3.13 INSULATED FLEXIBLE ROUND DUCTWORK

- A. Connect diffusers or troffer boots to low pressure ducts with 6 feet maximum length of flexible duct.
- B. Install flexible ducts in a fully extended condition, free of sags and kinks, using only the minimum length required to make the connection. Bends shall be made with not less than one duct diameter centerline radius. Provide Flexmaster FlexRight radiused supports as necessary.
- C. Where horizontal flex duct sags more than ½ inch per foot, suspend flexible duct on 35-inch centers with a minimum one inch wide flat bending material.
- D. Where "lift-out" ceilings occur, install with volume damper in flex duct at connection to main duct.
- E. Make all connections to metal ducts, diffusers, and troffer boots with draw bands or metal clamps. Use only continuous lengths of flexible duct, no joints are allowed between two lengths of flexible ducts.

3.14 FLEXIBLE DUCT FAN CONNECTIONS

- A. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.
- B. At least 1-inch slack shall be allowed in these connections to insure that no vibration is transmitted from fan to duct work. The fabric shall either be folded in with the metal or attached with metal collar frames at each end to prevent air leakage.

3.15 DUCT ACCESS DOORS

- A. Provide duct access doors for inspection, maintenance and cleaning at all automatic dampers, flow station, humidifiers, fire and smoke dampers and duct turning vanes and before and after all booster coils.
- B. Provide minimum 8 x 8 inch size for hand access, 24 x 24 inch size for shoulder access, unless indicated otherwise on drawings.

END OF SECTION 233300

**SECTION 233400
AIR HANDLING FANS**

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Cabinet Fans
- B. Centrifugal Fans
- C. In-Line Centrifugal Fans
- D. Power Roof Ventilators
- E. Exhaust Fans (Ceiling Type)

1.2 RELATED WORK

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this section and Contractor shall review and adhere to all requirements of these documents.
 - 1. Section 230500 - Basic Mechanical Requirements.
 - 2. Section 230529 - Basic Mechanical Materials and Methods.
 - 3. Section 230540 - Mechanical Sound and Vibration Control.
 - 4. Section 230548 - Mechanical Seismic Control.
 - 5. Section 230593 - Testing, Adjusting and Balancing.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of specified fans with characteristics, sizes, and capacities required, whose specified fan has been in satisfactory use in similar service for not less than 3 years.

1.4 SUBMITTALS

- A. Submit shop drawings and product data for the following items under provisions of the General Conditions of the Contract:
 - 1. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, weight loadings, required clearances, construction details, and field connection details for each fan.
 - 2. Product Data: Submit manufacturer's technical product data for all fans showing dimensions, weights, capacities, ratings, fan performance curves with operating point clearly indicated, motor electrical characteristics, gages and finishes of materials. Provide multiple-speed performance curves for fans with variable speed drives.
- B. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:
 - 1. All fans.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver fans with factory-installed shipping skids and lifting lugs; pack components in factory-fabricated protective containers.
- B. Handle fans carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to fan manufacturer.
- C. Store fans in clean dry place and protect from weather and construction traffic.
- D. Comply with Manufacturer's rigging and installation instructions for unloading fans and moving them to final location.

1.6 EXTRA STOCK

- A. Provide one spare set of belts for each belt-driven fan.

PART 2 PRODUCTS

2.1 CABINET FANS

- A. Acceptable Manufacturers: Subject to compliance with requirements, provide cabinet fan of one of the following: Loren Cook, Greenheck, Twin City, Trane, New York Blower, ACME, Peerless, Barry, Penn, Carnes, Soler and Palau.
- B. Furnish and install cabinet fans of size and capacity shown on drawings.
- C. Cabinet shall be constructed of steel with removable panels for access to all internal parts.
- D. Fan shall be double width, double inlet multi-blade centrifugal type with V-belt drive and adjustable speed sheave.
- E. Fans shall be statically and dynamically balanced and shall run on permanently lubricated bearings.
- F. Motor shall be provided per requirements of "Motors" in Section 230529.

2.2 CENTRIFUGAL FANS

- A. Acceptable Manufacturers: Subject to compliance with requirements, provide centrifugal fan of one of the following: Twin City, Trane, New York Blower, Pace, ACME, Cook, Barry, Carnes, Soler and Palau.
- B. Type: The fans to be backward inclined air-foil type completely assembled with fan, fan scroll, motor, belt, drive, belt guard and motor mount, capacity and arrangement as shown on the Drawings, and certified performance tests by Air Moving and Conditioning Association (AMCA) to be submitted with the shop drawing.
- C. Housing: To be constructed of steel sheet and parts to be bonderized and then coated with baked primer-finisher. The fan scroll to be attached to the side plates by means of continuous lock seam or welded seam construction.

- D. Bearings: The bearings to be of the self-aligning, grease pack pillow block type.
- E. Motor and Drive: To be belt driven with adjustable motor sheave. Motor nameplate horsepower shall exceed brake horsepower by a minimum of five percent. Belts to be of the oil resistant type. Motor to be especially designed for quiet operation and in accordance with "Motors" in Section 230529. Provide variable frequency drives where indicated, in accordance with Section 230810.

2.3 POWER ROOF VENTILATORS

- A. Acceptable Manufacturers: Subject to compliance with requirements, provide Power Roof Ventilator of one of the following: ACME, Jenn-Air, Penn, Greenheck, Cook, Powerline, Carnes, Twin City Fans, Soler and Palau.
- B. Furnish and install Power Roof Ventilators of model, size and capacity as shown on Drawings.
- C. Housings shall be of contour, type, and material as shown on drawings.
- D. Fan: Shall be the backwardly inclined type with centrifugal wheel that has been statically and dynamically balanced at the factory.
- E. Motor: Shall be installed in a totally enclosed weatherproof housing outside of the air stream and in accordance with "Motors" in Section 230529.
- F. Drive: Units shall be belt driven. Belt shall be oil resistant. An adjustable sheave on the motor shall be provided to allow changes in the fan speed.
- G. Installation: Ventilators shall be installed on the roof on a nominal 12-inch high, pre-fabricated, self-flashing aluminum curb with 2" fiberglass insulation and metal liner, furnished with the fan.
- H. Disconnect Switch: A factory wired non-fused disconnect switch shall be located under the hood of the unit.
- I. Backdraft Dampers: Shall be installed on the curb of the unit unless specifically shown otherwise on the Drawings.
- J. Bird Screen: Entire air outlet of the fan shall be protected by a 1/2" x 1/2" aluminum mesh securely installed in place.

2.4 EXHAUST FANS (CEILING TYPE)

- A. Acceptable Manufacturer: Subject to compliance with requirements, provide ceiling type exhaust fan of one of the following: Penn Co. (Zephyr Model), ILG, Pace, Cook, Jenn-Air, Greenheck, ACME, Carnes, Twin City Fan, Broan, Soler and Palau.
- B. Type: Shall be of the centrifugal fan, integral grille and housing type, all completely self-contained.
- C. Capacity: Capacity and model number of the units shall be as shown on drawings, and shall be certified by AMCA.

- D. Motor and Drive: Fan shall be of the direct drive type, and maximum fan motor speed shall be 1150 RPM. Motor shall be of the permanently lubricated ball bearing type, and shall be directly coupled to the fan. The motor and fan shall be easily removable thru the intake grille for service. Direct drive fans to include solid state speed controllers.
- E. Housing: Shall be constructed of heavy gauge steel, and shall be completely insulated internally with acoustical insulation material to deaden sound.
- F. Backdraft Damper: Each fan shall be equipped with a nonmetallic backdraft damper constructed of neoprene and shall be shatterproof under all conditions.
- G. U.L. Label: Each fan shall be approved by the Underwriters' Laboratories, Inc. and shall carry the U.L. Label.
- H. Intake Grille: Shall be constructed of steel frame and woven steel grille with a minimum free area of 85%. Intake grille shall have a white, factory baked enamel finish.

PART 3 EXECUTION

3.1 INSTALLATION OF FANS

- A. Install fans where indicated, in accordance with equipment manufacturer's installation instructions, and with recognized industry practices, to ensure that equipment complies with requirements and serves intended purposes.
- B. Coordinate with other work, including ductwork, floor construction, and electrical work as necessary to interface installation of air handling equipment with other work.
- C. Access: Provide access space around fans for service as indicated, but in no case less than that recommended by manufacturer.
- D. Do not operate fans for any other purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.
- E. Support: Install floor-mounted fans on 4" high reinforced concrete pad, 6" larger on each side than unit base in accordance with Section 230529.
- F. Mounting: Mount fans on vibration isolators, in accordance with manufacturer's instructions and Section 230540.
- G. Seismic Restraint: Provide seismic restraints in accordance with Section 230548.
- H. 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 with rotation in direction indicated and intended for proper performance. If there is no rotation arrow supplied by the manufacturer, install a correct rotation arrow.

- I. Duct Connections: Refer to Division 23 Air Distribution sections. Provide ductwork, accessories, and flexible connections as indicated.

3.2 FIELD QUALITY CONTROL

- A. Upon completion of installation of air handling equipment, and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected.

3.3 EXTRA BELTS

- A. Deliver one spare set of belts for each belt-driven fan unit, obtain receipt from Owner that belts have been received.

END OF SECTION 233400

**SECTION 233600
AIR TERMINAL UNITS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. VAV Single Duct Terminal Units.

1.2 RELATED REQUIREMENTS

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.
- B. Section 230500 - Basic Mechanical Requirements.

1.3 RELATED SECTIONS

- A. Section 230529 - Basic Mechanical Materials and Methods.
- B. Section 230900 - Electronic Controls.
- C. Section 230593 – Testing, Adjusting, and Balancing.

1.4 SUBMITTALS

- A. Submit Product Data for the following items under provision of The General Conditions of the Contract:
 - 1. VAV room terminals..
 - 2. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate air flow, static pressure, and NC designation.
 - 3. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of one to 4 inch wg.
- B. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500.
 - 1. VAV room terminals.

PART 2 PRODUCTS

2.1 VAV LOW PRESSURE ZONE TERMINAL UNITS

- A. Approved manufacturers: Titus Model ESV, Carnes, Krueger, Price, Metal Air, Carrier, Tuttle & Bailey, Anemostat, Enviro-Tec.
- B. Terminal units designated of sizes shown on Drawings or terminal unit schedule. Units shall have factory catalog performance ratings which conform to cfm, static pressure, discharge and radiated sound power and attenuation designated.

- C. Construction:
1. Cabinets constructed of minimum 22 gauge galvanized steel. Casing fabricated to prevent air leakage of no more than 3 cfm at 1-inch w.g. inlet static pressure. Internal surfaces acoustically and thermally insulated with 1" glass fiber material surface treated to prevent erosion and complying with UL 181, NFPA-90, ASTM C 1071, and ASTM E 84. All surfaces in contact with the supply air shall comply with the requirements of the current edition of ASHRAE Standard 62.1.
 2. Air volume damper assemblies made from exactly dimensioned extruded anodized aluminum components. Damper blades shall have extruded ribs which key into grooved shaft for permanent fix of damper. All internal damper pivot points shall include bearings for noiseless operation requiring no lubrication. Damper assemblies constructed to prevent air leakage in excess of 2% of design airflow at 3-inch w.g. inlet static pressure.
- D. Differential Pressure Airflow Sensors: Averaging, multi-point total and static pressure port array with amplified signal and gauge taps. Velocity pressure to be determined by measuring difference between total and static pressure. Accuracy shall not exceed +/- 5% at an air velocity of 2,000 FPM. Developed differential pressure not less than 0.03" w.g. at an air velocity of 450 fee/minute.
- E. Performance Testing and Rating:
1. Performance of units shall be rated in accordance with the current edition of AHRI Standard 880.
- F. Controls:
1. Controls shall be electronic type as specified in Section 230900. Electric and electronic control devices shall be contained in a factory installed NEMA-1 enclosure with access panel sealed from airflow and mounted on side of VAV box.
- G. Hot Water Coils:
1. Provide, where indicated, terminal units with factory mounted reheat coils, with performance and rows as indicated on schedules. Coils to consist of copper tubes with mechanically bonded aluminum fins and shall be rated for a minimum working pressure of 200 psig.
 2. Coils shall be tested and certified in accordance with ARI Standard 410.
 3. Coils to be installed so that supply water enters at the bottom and back of coil, rotate coil to accommodate. Improperly installed coils will be reinstalled at Contractor's expense.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide ceiling access doors or locate above easily removable ceiling components.
- C. Support units individually from structure. Do not support from adjacent ductwork.
- D. Connect to ductwork in accordance with Section 233300. Allow minimum 2.5 times duct diameter of straight hard duct at terminal inlet.

3.2 ADJUSTING VAV TERMINAL UNITS

- A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to 0 percent full flow. Set units with heating coils for minimum flow rates per VAV box schedule.

END OF SECTION 233600

**SECTION 233713
AIR INLETS AND OUTLETS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Diffusers.
- B. Registers.
- C. Grilles.
- D. Louvers.
- E. Louvered penthouses.
- F. Gravity roof hoods.
- G. Goosenecks.

1.2 RELATED REQUIREMENTS

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.
- B. Section 230500- Basic Mechanical Requirements.

1.3 RELATED SECTIONS

- A. Section 230529 - Basic Mechanical Materials and Methods: Painting of ductwork visible behind outlets and inlets.
- B. Section 233300 - Ductwork and Accessories.
- C. Section 233600 - Air Terminal Units.
- D. Section 230593 - Testing, Adjusting and Balancing.

1.4 REFERENCES

- A. AMCA 500 - Test Method for Louvers, Dampers and Shutters.
- B. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- C. ARI 890-91 - Rating of Air Diffusers.
- D. ASHRAE 70 - Methods of Testing for Rating the Air Flow Performance of Outlets and Inlets.
- E. SMACNA - HVAC Duct Construction Standard.
- F. ASTM C 636 – Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.

1.5 QUALITY ASSURANCE

- A. Test and rate performance of air outlets and inlets in accordance with ASHRAE 70 and ARI 890.
- B. Test and rate performance of louvers in accordance with AMCA 500.

1.6 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A.

1.7 SUBMITTALS

- A. Submit Shop Drawings for the following items under provision of The General Conditions of the Contract:
 - 1. Shop fabricated louvers.
 - 2. Louvered penthouses.
 - 3. Shop fabricated roof hoods.
 - 4. Goosenecks.
- B. Submit Product Data for the following items under provision of The General Conditions of the Contract:
 - 1. Diffusers.
 - 2. Registers.
 - 3. Grilles.
 - 4. Louvers.
 - 5. Gravity roof hoods.
- C. Submit schedule of outlets and inlets indicating type, size, location, application, and noise level.
 - 1. Review requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data and schedules of outlets and inlets.

PART 2 PRODUCTS

2.1 CEILING DIFFUSERS (SEE AIR DEVICE SCHEDULE ON PLANS)

- A. Acceptable Manufacturers: Titus, Anemostat, Barber Colman, Krueger, Carnes, Metal-Aire, Nailor-Hart, Tempo, Air Diffusion Products, Tuttle & Bailey, Price, Hart & Cooley.
- B. Ceiling Diffusers located in hard ceilings are configured to be secured with concealed fasteners or to lay in a gyp board frame.
- C. Radial Diffusers have different active face areas that increase as neck size increases.

2.2 CEILING REGISTERS AND GRILLES (SEE AIR DEVICE SCHEDULE ON PLANS)

- A. Acceptable Manufacturers: Titus, Anemostat, Barber Colman, Krueger, Carnes, Metal-Aire, Nailor-Hart, Tuttle & Bailey, Price, Hart & Cooley.
- B. Ceiling Registers and Grilles located in hard ceilings are configured to be secured with concealed fasteners or to lay in a gyp board frame.

2.3 CEILING SLOT DIFFUSERS (SEE AIR DEVICE SCHEDULE ON PLANS)

- A. Acceptable Manufacturers: Anemostat, Tempmaster, Tempo. (No Substitutions Allowed).
- B. Ceiling Slot Diffusers located in hard ceilings are configured to be secured with concealed fasteners or to lay in a gyp board frame.

2.4 CEILING LINEAR EXHAUST AND RETURN GRILLES (SEE AIR DEVICE SCHEDULE ON PLANS)

- A. Acceptable Manufacturers: Titus, Barber-Colman, Metal-Aire, Anemostat, Krueger, Tuttle & Bailey, Price.
- B. Ceiling Linear Exhaust and Return Grilles located in hard ceilings are configured to be secured with concealed fasteners or to lay in a gyp board frame.

2.5 WALL REGISTERS AND GRILLES (SEE AIR DEVICE SCHEDULE ON PLANS)

- A. Acceptable Manufacturers: Titus, Metal-Aire, Barber-Colman, Anemostat, Krueger, Tuttle & Bailey, Air Concepts, Price.

2.6 LINEAR WALL REGISTERS AND GRILLES (SEE AIR DEVICE SCHEDULE ON PLANS)

- A. Acceptable Manufacturers: Titus, Barber-Colman, Metal-Aire, Anemostat, Krueger, Price, Tuttle & Bailey.

2.7 LINEAR SUPPLY REGISTERS AND GRILLES (SEE AIR DEVICE SCHEDULE ON PLANS)

- A. Acceptable Manufacturers: Titus, Barber-Colman, Metal-Aire, Anemostat, Krueger, Price, Tuttle & Bailey.

2.8 LINEAR FLOOR REGISTERS AND GRILLES (SEE AIR DEVICE SCHEDULE ON PLANS)

- A. Acceptable Manufacturers: Titus, Barber-Colman, Metal-Aire, Anemostat, Krueger, Price, Tuttle & Bailey.

2.9 LOUVERS

- A. Acceptable Manufacturers: Dowco, Airstream, Louvers and Dampers, Inc., Ruskin, Krueger, Air Balance, American Warming and Ventilating, Arrow, C. E. Sparrow, Greenheck, Cesco, Pottorff, Air-Rite.

- B. Provide 6 inch deep louvers with blades on 45 degree slope with center baffle and return bend, heavy channel frame, birdscreen with 1/2 inch square mesh for exhaust and 3/4 inch for intake.
- C. Fabricate of 12 gauge extruded aluminum, welded assembly, with factory baked enamel finish, custom color to be selected by Architect.
- D. Furnish with interior angle flange for installation.

2.10 LOUVERED PENTHOUSES

- A. Acceptable Manufacturers: Louvers and Dampers, Inc., Dowco, Penn Ventilator, Greenheck, Ruskin, Arrow, American Warming, Cook, Air-Rite, Carnes.
- B. Louvered penthouse with 6 inch deep 45 degree slope .081 inch thick extruded aluminum stormproof louvers with heliarc welded mitered corners, heavy channel frame with sill extension, removable insect screen and removable roof.
- C. Fabricate removable roof of sheet aluminum reinforced with aluminum angle bracing and stainless steel fasteners as required to withstand a design snow load of 40 pounds per sq. ft. plus safety factor and undercoat with mastic sound deadener or heavy ductboard acoustical insulation.

2.11 GRAVITY ROOF HOODS

- A. Acceptable Manufacturers: Acme, Louvers and Dampers, Inc., Penn Ventilator, Greenheck, Ruskin, Cook, Carnes.
- B. Fabricate air inlet or exhaust hoods in accordance with SMACNA Low Pressure Duct Construction Standards.
- C. Fabricate of galvanized steel, minimum 16 gauge base and 20 gauge hood, or aluminum, minimum 16 gauge base and 18 gauge hood; suitably reinforced; with removable hood; birdscreen with 1/2 inch square mesh for exhaust and 3/4 inch for intake, and factory baked enamel finish.
- D. Provide minimum 12 inch high insulated curb base.
- E. Make hood outlet area minimum of twice throat area.

2.12 GOOSENECKS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards of minimum 18 gauge galvanized steel.
- B. Mount on minimum 12 inch high curb base.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install items in accordance with manufacturers' instructions.

- B. Install ceiling mounted items in accordance with ASTM C 636.
 - 1. Ceiling mounted air terminals or services weighing less than 20 pounds shall be positively attached to the ceiling suspension main runners or to cross runners with the same carrying capacity as the main runners.
 - 2. Terminals or services weighing 20 pounds but not more than 56 pounds, in addition to the above, shall have two No. 12 gauge hangers connected from the terminal or service to the ceiling system hangers or to the structure above. These wires may be slack.
 - 3. Terminals or services weighing more than 56 pounds shall be supported directly from the structure above by approved hangers.
- C. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, regardless of whether dampers are specified as part of the diffuser, or grille and register assembly.
- E. Paint ductwork visible behind air outlets and inlets matte black.
- F. Install diffusers to ductwork with air tight connection.
- G. Air devices located in hard ceilings are to be secured with concealed fasteners or must be provided with a hard ceiling frame for lay-in installation. Unless noted otherwise in documents, do not secure with visible screws.
- H. Install duct connections to fire rated UL Listed and Labeled diffusers and return grilles in strict accordance with instructions furnished by manufacturer.

END OF SECTION 233713

**SECTION 235100
BREECHINGS, CHIMNEYS, STACKS, AND FLUES**

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Positive Pressure Double-Wall Special Gas Vent.
- B. Barometric Damper.

1.2 RELATED WORK

- A. Requirements: Provide Breechings, Chimneys, Stacks, and Flues in accordance with the Contract Documents.
- B. Section 230500 – Basic Mechanical Requirements.
- C. Section 230529 – Basic Mechanical Materials and Methods.
- D. Section 224450 – Plumbing Equipment.
- E. Section 230548 – Mechanical Seismic Control
- F. Section 235200 – Boilers.

1.3 REFERENCES

- A. Reference Standards: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:

UL 1738 – Venting Systems for Gas-Burning Appliances, Categories II, III, and IV.

1.4 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacturing prefabricated special gas venting system components, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.5 SUBMITTALS

- A. Submit Shop Drawings for the following items under provisions of the General Conditions of the Contract:
 - 1. Positive Pressure Double-Wall Special Gas Vent.
- B. Submit Product Data for the following items under provisions of the General Conditions of the Contract:
 - 1. Positive Pressure Double-Wall Special Gas Vent.
 - 2. Barometric Damper.

- C. Contractor shall submit a gas venting system analysis performed for the fuel-fired equipment being furnished and installed as part of this project. Flue sizes shall be modified as necessary to accommodate the brand/model of fuel-fired equipment being provided as part of this project and to accommodate the routing of the flue indicated on the contractor's shop drawings.
- D. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:
 - 1. Positive Pressure Double-Wall Special Gas Vent.
 - 2. Barometric Damper.

PART 2 PRODUCTS

2.1 POSITIVE PRESSURE DOUBLE-WALL SPECIAL GAS VENT

- A. Acceptable Manufacturers: Selkirk PS, Heatfab CI Plus / CI 316, Duravent FasNSeal W2, Metal-Fab Corr/Guard, Schebler eVent, Cheminee Lining HEPL, Van Packer CS, Jeremias Inc DWGV.
- B. General: Provide double-wall metal gas vent, U.L. Listed for use with Category IV appliances.
- C. Material: Double-wall metal vent with outer jacket of aluminum coated steel with minimum one inch air space between the walls and inner gas-carrying pipe of Type AL 29-4C or 316L stainless steel.
- D. Accessories: Provide manufacturer's standard accessory items including flanged boiler kits, clamp flanges, elbows, increasers, tees, wyes, drain sections, wall supports, wall guides, floor guides, plate supports, roof supports, ventilated roof thimbles, flashings, storm collars, exit cones, open stack top rings, and stack caps as indicated and required for complete installation.
- E. Seals: Factory adhered seals or approved sealant. For flue gas temperatures up to 600 degrees F, any RTV Silicone Sealant. All joints shall be gas and liquid tight.

2.2 BAROMETRIC DAMPER

- A. Acceptable Manufacturer: Barometric damper manufacturer shall match manufacturer of special gas vent listed above.
- B. Match size to appliance vent diameter.
- C. Construction: Heavy duty design with stainless steel knife-edge bearing and precision balanced gate.
- D. Control: Adjustable wide range of draft settings from .002 inches to .5 inches.

PART 3 EXECUTION

3.1 POSITIVE PRESSURE DOUBLE-WALL SPECIAL GAS VENT

- A. Install in accordance with Manufacturer's installation instructions. Maintain UL-Listed minimum clearances from combustibles as described in NFPA 211, Section 2-3.1 and Appendix A. Assemble manifold, stack, and accessories as indicated for complete installation.
- B. If not equipped with factory adhered seals, seal inner pipe joints during field assembly with any RTV Silicone Sealant to assure positive internal pressure requirements. Allow 24 hours for any field-applied sealant to fully cure before operating the appliance.
- C. Terminate vent pipe extending above roof surfaces as required by local code.

3.2 BAROMETRIC DAMPER

- A. Install in accordance with Manufacturer's instructions and in Manufacturer's recommended best location for specified fuel and flue configuration.

END OF SECTION 235100

SECTION 235216 CONDENSING BOILERS

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 gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
 - 5. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.4 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Fire-Tube Condensing Boilers:
 - a. Leakage and Materials: 10 years from date of Substantial Completion.
 - b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Prorated for five years from date of Substantial Completion.

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.
- B. Utah State and Pressure Vessel Compliance Manual, issued by Utah Labor Utah Labor Commission Division of Boiler, Elevator, and Coal Mine Safety
- C. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.
- D. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- E. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N.
- F. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- G. Mounting Base: For securing boiler to concrete base.
 - 1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when mounting base is anchored to building structure.

2.2 FORCED-DRAFT, FIRE-TUBE CONDENSING BOILERS

- A. Acceptable Manufacturers: Aerco Benchmark, Camus Advantus, Cleaver Brooks Clearfire C, Fulton Endura, Fulton Vantage, Lochinvar Crest, Viessmann CA3, Viessmann CM2
- B. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.
- C. Heat Exchanger: Nonferrous, corrosion-resistant combustion chamber.
- D. Pressure Vessel: Carbon steel with welded heads and tube connections.
- E. Burner: Natural gas, forced draft.
- F. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- G. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

H. Casing:

1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: Baked-enamel protective finish.
4. Insulation: Mineral-fiber or polyurethane-foam insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.

I. Capacities and Characteristics

1. Heating Medium: Hot water.
2. Design Water-Pressure Rating: 160 psig.
3. Safety Relief Valve Setting: 110 psig.
4. Minimum Thermal Efficiency: 90 percent.

2.3 TRIM

- A. Include devices sized to comply with ASME B31.1.
- B. Aquastat Controllers: Operating, and high limit.
- C. Safety Relief Valve: ASME rated.
- D. Pressure and Temperature Gage: Minimum 3-1/2-inch diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.
- E. Boiler Air Vent: Automatic.
- F. Drain Valve: Minimum NPS 3/4 hose-end gate valve.

2.4 CONTROLS

- A. Controls:
 1. Control transformer.
 2. Set-Point Adjust: Set points shall be adjustable.
 3. Sequence of Operation – See Drawings.
- B. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
 1. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature.
 2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
 3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.

- C. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
 - 1. Hardwired Points:
 - a. Monitoring: On/off status, common trouble alarm low-water-level alarm
 - b. Control: On/off operation, hot-water-supply temperature set-point adjustment.
 - 2. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

2.5 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
 - 1. House in NEMA 250, Type 1 enclosure.
 - 2. Wiring shall be numbered and color coded to match wiring diagram.
 - 3. Install factory wiring outside of an enclosure in a metal raceway.
 - 4. Field power interface shall be to fused disconnect switch.
 - 5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
 - 6. Provide each motor with overcurrent protection.

2.6 VENTING AND COMBUSTION AIR PIPING

- A. Provide venting in accordance with Specification Section 235100. Vent piping for boilers using common venting shall be sized by the equipment manufacturer.
- B. Combustion air intake piping material shall match vent material. Combustion air intake piping for boilers using common intake piping shall be sized by the equipment manufacturer. Intake piping shall be double-wall construction with minimum one inch thick factory-installed fiber insulation in the annular space between the inner and outer walls.
- C. Boiler exhaust vent and intake pipe lengths shall be able to extend to 100 equivalent feet.
- D. Common vented boilers shall be furnished with manufacturer's common vent kit damper, as applicable.

2.7 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Equipment Mounting:
 - 1. Install boilers on cast-in-place concrete equipment base(s).
 - 2. Comply with requirements for vibration isolation and seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
 - 3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E.
- F. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 232116 "Hydronic Piping Specialties."
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tapplings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Boiler Venting:
 - 1. Install flue venting kit and combustion-air intake.
- I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- D. Boiler will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

G. Performance Tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.
 - a. Test for full capacity.
 - b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.
7. Notify Architect 24 hours minimum in advance of test dates.
8. Document test results in a report and submit to Architect.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 235216

**SECTION 235700
HEAT TRANSFER**

PART 1 GENERAL

1.1 RELATED WORK

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.
- B. Related work specified in other Sections:
 - Section 230500 - Basic Mechanical Requirements
 - Section 230529 - Basic Mechanical Materials and Methods
 - Section 230540 - Mechanical Sound and Vibration Control
 - Section 230593 - Testing, Adjusting and Balancing
 - Section 230700 - Mechanical Insulation
 - Section 230900 - Electronic Controls
 - Section 232113 - HVAC Piping and Specialties
 - Section 232123 - HVAC Pumps
 - Section 233400 - Air Handling Fans
 - Section 236400 - Refrigeration

1.2 SYSTEM DESCRIPTION

- A. The work includes, but is not limited to providing the following:
 - 1. Finned Tube Radiation
 - 2. Unit Heaters
 - 3. All contactors, relays, terminal boxes, thermostats and other electrical appurtenances for electric heat in accordance with "ELECTRIC WIRING" paragraph in Section 230529 - Basic Mechanical Materials and Methods.

1.3 QUALITY ASSURANCE

- A. Quality control shall be in accordance with Section 230500 - Basic Mechanical Requirements.

1.4 REFERENCES

- A. Reference Standards: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:
 - 1. Comply with American National Standards Institute (ANSI B31.1) Code for Pressure Piping.

1.5 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings and Product Data for the following items in accordance with the General Conditions of the Contract:
 - 1. Finned Tube Radiation
 - 2. Unit Heaters

- B. Operating Instructions and Maintenance Data: Submit printed Operating Instructions and Maintenance Data for the following items in accordance with Operating and Maintenance Data paragraph in Section 230500:
 - 1. Finned Tube Radiation
 - 2. Unit Heaters

PART 2 PRODUCTS

2.1 FINNED TUBE RADIATION

- A. Acceptable Manufacturers: Dunham-Bush, Vulcan, Standard, ITT Nesbitt, A.A.F., Sterling, Trane, C.P. AAON, Airtherm, Modine, Rittling.
- B. Radiation to be copper tubes with aluminum fins having heating capacity as scheduled on Drawings.
- C. Provide I-B-R ratings for all radiation combinations scheduled on Drawings.
- D. Equipment shall be rated for minimum 250 PSI working pressure at 250°F.
- E. Equipment and enclosures shall be complete with support brackets, joining pieces, and end enclosures.

2.2 FINNED TUBE HEATERS

- A. Enclosures shall be of heights scheduled on drawings with the following features:
 - 1. Minimum 14 gauge aluminum wall-mounted enclosure with powder coated finish. Color to be selected by Architect from manufacturer's standard color options.
 - 2. Unless noted otherwise on Drawings, furnish with top outlet grille with heavy duty extruded aluminum "pencil proof" construction.
 - 3. Heaters with multiple sections shall be joined via male and female slip joints for positive engagement and alignment of adjoining enclosures.
 - 4. Backplate shall be full height, constructed of 20 gauge galvanized steel with die-formed mounting channel into which the enclosure shall self-locate and secure.
 - 5. Enclosures shall include 12" wide valve compartment with hinged access door for access to controls, valves, etc. located within the enclosure.
 - 6. Enclosures shall include end caps, corner elbows, etc. as required for a fully finished installation.

2.3 UNIT HEATER (HORIZONTAL BLOW)

- A. Acceptable Manufacturers: Modine, Carrier, Trane, A.A.F., KHD Inc., Airtherm, ITT-Nesbitt, Sterling, McQuay, Beacon Morris, Vulcan Inc., Rittling.
- B. Type: Unit heater shall be of the horizontal blow thru propeller fan type with hot water heating coil, capacities as shown on the drawings.
- C. Casing: Shall be constructed of heavy gauge furniture steel. It shall be phosphatized and completely dip painted with a heavy duty baked enamel. Cast brass supply and return pipe tap connections shall be bolted to corners of the back.

- D. Hot Water Heating Coil: Shall be serpentine connected of the finned copper tubing type, hydrostatically tested to twice the working pressure. Coil capacity shall be rated at low fan speed. Coil piping connection shall be on side of unit, not on top and bottom.
- E. Fan: Shall be selected for quiet operation and shall be factory balanced.
- F. Speed Control: Units to be furnished with speed control for low speed setting. Include "summer" fan switch for fan-only operation.
- G. Motor: Shall be equipped with permanently lubricated bearings and shall be in accordance with "Motors" in Section 230529. Include all contactors/starters required for automatic operation.
- H. Louvers: Unit shall be equipped with lateral and horizontal diffusion.

PART 3 EXECUTION

3.1 UNIT HEATERS (HORIZONTAL BLOW)

- A. Unless noted otherwise, mount high as possible to give greatest headroom possible. Piping shall be as shown on the plans.
- B. Protect the entire unit with a cover during construction.
- C. Manufacturers data is to be observed before installation.

END OF SECTION 235700

**SECTION 236400
REFRIGERATION**

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Cassette-Style Cooling Only Ductless Dx Fan Coil Split-Systems with Air-Cooled Condensing Units
- B. Refrigerant Piping Materials and Products

1.2 RELATED WORK

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this section, and Contractor shall review and adhere to all requirements of these documents.
- B. Related work specified in other Sections:
 - Section 230500 - Basic Mechanical Requirements
 - Section 230529 - Basic Mechanical Materials And Methods
 - Section 230540 - Mechanical Sound and Vibration Control
 - Section 230548 - Mechanical Seismic Control
 - Section 230700 - Mechanical Insulation
 - Section 232113 - HVAC Piping & Specialties
 - Section 232123 - HVAC Pumps
 - Section 232500 - HVAC Water Treatment
 - Section 230593 - Testing, Adjusting and Balancing

1.3 REFERENCES

- A. Reference Standards: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:
 - 1. Air Conditioning and Refrigeration Institute (ARI):
 - Standards for the following:
 - # 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment
 - # 270 - Sound Rating of Outdoor Unitary Equipment
 - # 410-72 - Plate Fin Type Refrigerant Coils
 - # 450 - Water Cooled Condensers
 - # 460 - Remote Mechanical-Draft Air Cooled Condensers
 - # 520 - Positive Displacement Condensing Units
 - # 550/590 - Water Chilling Packages using the Vapor Compression Cycle
 - # 575 - Method of Measuring Machinery Sound within an Equipment Space

2. American National Standards Institute (ANSI):

ANSI B9.1 "Safety Code for Mechanical Refrigeration." (Also known as ANSI/ASHRAE 15).

ANSI B31.5 "Refrigeration Piping," and extend applicable lower pressure limits to pressures below 15 psig.

1.4 QUALITY ASSURANCE

- A. Quality control shall be in accordance with Section 230500 - Basic Mechanical Requirements.
- B. The firm installing the refrigeration piping shall have at least 3 years of successful installation experience on projects with refrigeration piping system work similar to that required for this project.
- C. Brazing Qualifications: Certify operators, brazing procedures and brazers in accordance with ANSI B31.5 for shop and job-site brazing of refrigerant piping work.

1.5 WARRANTY

- A. All refrigerant compressors in this specification section shall be provided with a four year extended warranty for parts and labor in addition to the standard one year warranty required in Section 230500, for a total of 5 years of warranty coverage.

1.6 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings and Product Data for the following items in accordance with the General Conditions of the Contract:
 - 1. Cassette-Style Cooling Only Ductless Dx Fan Coil Split-Systems with Air-Cooled Condensing Units
 - 2. Refrigerant Specialties
- B. Certificates: Before proceeding with refrigerant piping work, submit to the Architect/Engineer/Construction Manager/General Contractor two copies of Certification that brazing procedures, brazers and operators will be in accordance with ANSI B31.5.
- C. Operating Instructions and Maintenance Data: Submit printed Operating Instructions and Maintenance Data for the following items in accordance with Operating and Maintenance Data paragraph in Section 230500.
 - 1. Cassette-Style Cooling Only Ductless Dx Fan Coil Split-Systems with Air-Cooled Condensing Units
 - 2. Refrigerant Specialties

PART 2 PRODUCTS

2.1 CASSETTE-STYLE COOLING-ONLY DUCTLESS DX FAN COIL SPLIT SYSTEMS WITH AIR COOLED CONDENSING UNITS

- A. Acceptable Manufacturer: Carrier, Trane, York, Mitsubishi.
- B. Furnish and install factory assembled cooling-only split systems of the type, size and capacity shown on the equipment schedule on the Drawings. Unit performance shall be certified in accordance with latest edition of ARI Standards 210 and 270.
- C. Condensing units shall be of the packaged air cooled type as shown on the Drawings and consist of a rotary compressor, air cooled condenser and control panel completely factory wired and piped. Unit construction shall comply with ANSI B9.1 safety code, national electric code and ASME code.
- D. The condensing unit shall contain sufficient refrigerant (R134, R410A or R407) for complete system and be equipped with refrigerant line fittings which permit mechanical or sweat connection. Brass service valves with fittings and gage ports shall be located on exterior of unit.
- E. Compressor shall be of the welded hermetic type with internal vibration isolation and be located in an isolated section of unit.
- F. Controls shall be factory wired and placed in a location readily accessible from top of unit. Compressor motor shall have both thermal and current sensitive overload devices.
- G. Condenser coil shall be constructed with aluminum plate fins mechanically bonded to nonferrous tubing. Coil shall be protected by a grille. Condenser fan shall be propeller type, direct driven, and arranged for vertical air discharge. Fan motor shall be factory lubricated and internally protected.
- H. Unit to be housed in a fully weatherproof housing made of galvanized steel, zinc phosphatized, with a baked enamel finish.
- I. Condensing unit must be capable of serving DX fan coil located 22 vertical feet below the condenser.
- J. Fan coil to be of size and capacity indicated on the drawings. Fan coil to mount on vertical wall surface and have a maximum height of 14".
- K. Fan coil shall be complete with DX cooling coil, condensate pan and drain, direct drive fan, fan motor, filter, piping connectors, microprocessor control system, and integral thermostat. Include integral wall mounting bracket and mounting hardware.
- L. Fan coil cabinet to be fully insulated for improved acoustical and thermal performance.
- M. Fan coil to be configured with return air drawn in at top of front vertical face, and supply air discharged at bottom of front vertical face. Discharge to include manually adjustable horizontal and vertical deflection blades, as well as automatic motor driven vertical air sweep with on/off switch.

- N. Fan coil unit to include a remote control that allows users to turn unit on/off, change setpoints, and change from fan-only to cooling mode.
- O. Fan coil to connect to condensing unit for electrical power as necessary.
- P. Provide the following accessories:
 - 1. Start capacitor and relay.
 - 2. Indoor fan relay.
 - 3. Liquid line filter drier.
 - 4. Low ambient kit (0°F).
 - 5. Low voltage control transformer.
 - 6. Device to prevent damage to compressor caused by short cycling.
 - 7. Crankcase heater.
 - 8. 14" high roof curb or 4" high concrete if slab on grade.
 - 9. Factory installed starter and disconnect.

2.2 REFRIGERANT PIPING MATERIALS AND PRODUCTS

- A. General:
 - 1. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature 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 ANSI B31.5 Code for Refrigeration Piping where applicable, base pressure rating on refrigeration piping system on maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in refrigeration piping systems. Where more than 1 type of materials or products are indicated, selection is Installer's option.
- B. Basic Pipe, Tube and Fittings:
 - 1. Provide pipe, tube and fittings in accordance with the following:
 - Tube Size 3/4" and Smaller: Copper tube.
 - Wall Thickness: Type ACR, soft annealed temper.
 - Fittings: Cast copper-allow for flared copper tubes, ANSI B16.26.
 - Joints: Flared.
 - Tube Size 7/8" through 4-1/8": Copper tube.
 - Wall Thickness: Type ACR, soft annealed temper.
 - Fittings: Wrought-copper, solder-joints.
 - Joints: Brazed or soldered.
- C. Refrigeration Valves:
 - 1. Globe and Check Valves:
 - a. Acceptable Manufacturers: Subject to compliance with requirements, provide globe and check valves of one of the following:
 - Henry Valve Co.
 - Parker Hannifin Corp., Refrigeration & Air-Conditioning Div.
 - Sporlan Valve Co.

- b. Globe Shutoff Valves: Forged brass, packed, back seating, winged seal cap, 300 deg.F (149 deg.C) temperature rating, 500 psi working pressure.
 - c. Check Valves: Forged brass, accessible internal parts, soft synthetic seat, fully guided brass piston and stainless steel spring, 250 deg.F (121 deg.C) temperature rating, 500 psi working pressure.
2. Solenoid Valves:
- a. Acceptable Manufacturers: Subject to compliance with requirements, provide solenoid valves of one of the following:

Alco Controls Div., Emerson Electric Co.
Automatic Switch Co.
Sporland Valve Co.
 - b. 2-Way Solenoid Valves: Forged brass, designed to conform to ARI 760, normally closed, Teflon valve seat, NEMA 1 solenoid enclosure, 115 volt, 60 Hz., UL-listed, 1/2" conduit adapter, 250 deg.F (121 deg.C) temperature rating, 400 psi working pressure.
- D. Refrigeration Accessories:
- 1. Acceptable Manufacturers: Subject to compliance with requirements, provide refrigeration accessories of one of the following:

Alco Controls Div., Emerson Electric Co.
Henry Valve Co.
Parker-Hannifin Corp., Refrigeration & Air-Conditioning Div.
Sporlan Valve Co.
Toxalert
 - 2. Refrigerant Strainers: Brass shell and end connections, brazed joints, Monel screen, 100 mesh, UL listed, 350 psi working pressure.
 - 3. Moisture-Liquid Indicators: Forged brass, single port, removable cap, polished optical glass, solder connections, UL listed, 200 deg.F (93 deg.C) temperature rating, 500 psi working pressure.
 - 4. Refrigerant Filter-Driers: Corrosion-resistant steel shell, steel flange ring and spring, wrought copper fittings, ductile iron cover plate with steel cap screws, replaceable filter-drier core, 500 psi working pressure.
 - 5. Evaporator Pressure Regulators: Provide corrosion-resistant, spring loaded, stainless steel springs, pressure operated, evaporator pressure regulator, in size and working pressure indicated, with copper connections.
 - 6. Refrigerant Discharge Line Mufflers: Provide discharge line mufflers as recommended by equipment manufacturer for use in service indicated, UL listed.

PART 3 EXECUTION

3.1 REFRIGERATION EQUIPMENT INSTALLATION

- A. General: Comply with manufacturer's recommended installation instructions.
- B. Provide sound and vibration isolation in accordance with Section 230540 - Mechanical Sound and Vibration Control.

- C. Equipment manufacturer to provide labor to assemble, test, charge, start-up, calibrate, and instruct Owner's personnel in operation and maintenance.

3.2 REFRIGERATION SYSTEM INSTALLATION

A. Refrigerant Piping:

1. General: Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Comply with ANSI B31 Code for Pressure Piping.
2. Piping to be kept clean and dry with factory installed caps in place until time of installation. Keep the entire system clean and dry during the installation. Piping to be straight and free of kinks, ripples, or restrictions of any kind. Bending the pipe will not be permitted. Fittings required to be of the long radius pattern except when used for oil traps.
3. Clean refrigerant piping by swabbing with dry lintless (linen) cloth, followed by refrigerant oil soaked swab. Remove excess oil by swabbing with cloth soaked in high flash point petroleum solvent, squeezed dry.
4. Pitch refrigerant piping 1" in 15 feet in direction of oil return to compressor. Provide oil traps and double risers where indicated, and where required to provide oil return.
5. Refrigeration system connections shall be of the sweat copper type properly cleaned and silver brazed with Sil-Fos or Easy-Flor solders using Handy and Harmon flux. Circulate nitrogen through tubes being soldered to eliminate the formation of copper oxide during the brazing operation.
6. Evacuation and leak test shall be made after refrigerant piping system is completed. The Contractor shall draw a vacuum on the entire system with a vacuum pump, the vacuum shall hold for 12 hours at 25 inches hg. of vacuum. The Contractor shall then break the vacuum with clean dry refrigerant, he shall then make a test with halide detector, after which he shall then draw another vacuum down to 25 in. and again break the vacuum with new clean dry refrigerant. The system shall then be fully charged with refrigerant and tested with halide detector at all joints.
7. Solder copper tube-and-fitting joints where indicated using silver-lead solder, ASTM B32, Grade 96 TS, in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
8. Braze joints using American Welding Society (AWS) classification BCuP-4 for brazing filler metal. Bleed dry nitrogen through refrigerant piping during brazing operations.
9. Provide pipe hangers and supports in accordance with Section 230529 - Basic Mechanical Materials and Methods.

B. Refrigerant Valves:

1. Provide refrigerant type hand valves where indicated on the Drawings and wherever required for routine servicing. Install in accordance with manufacturer's instructions. Remove accessible internal parts before soldering or brazing, replace after joints are completed.
2. Solenoid Valves: Install in refrigerant piping as indicated with stem pointing upwards. Wire in accordance with "Electric Wiring" paragraph in Section 230529 - Basic Mechanical Materials and Methods.

C. Refrigerant Accessories:

1. Liquid indicators, strainers and filter-drier: Furnish and install in each refrigerant circuit and in accessible location for service.
2. Evaporator Pressure Regulators: Install in refrigerant suction lines or evaporator outlets as indicated. Adjust, if required, for proper evaporator pressure.
3. Refrigerant Discharge Line Mufflers: Install as indicated, in horizontal or downflow portion of hot-gas lines, immediately after leaving compressor; not in riser.

D. Refrigerant Coils:

1. Mount refrigeration coils as shown on Drawings complete with drain pans and drain piping to floor drains.
2. Provide refrigeration piping with rubber sleeves to prevent vibration transmissions where piping passes thru plenum wall.

E. Equipment Connections:

1. General: Connect refrigerant piping to mechanical equipment in manner shown, and comply with equipment manufacturer's instructions where not otherwise indicated.
2. Provide flexible connections in suction and discharge lines at compressor and install valves where necessary for proper service and maintenance.
3. The oil level in the compressors to be checked or removed to achieve the correct level. The oil level to be rechecked after extended operation and adjusted accordingly.
4. Install refrigeration equipment on vibration isolation mountings in accordance with Section 230540 - Mechanical Sound and Vibration Control.

F. Dehydration and Charging System:

1. Install core in filter dryer after leak test but before evacuation.
2. Evacuate refrigerant system with vacuum pump, until temperature of 35 deg.F (2 deg.C) is indicated on vacuum dehydration indicator.
3. Provide manufacturer's recommended refrigerant charge to system to obtain optimum operating conditions.

END OF SECTION 236400

SECTION 260000 – GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide all items, articles, materials, equipment, operations and/or methods listed, mentioned, shown and/or scheduled on the drawings and/or in these specifications, including all labor, services, permits, fees, utility charges, and incidentals necessary and required to perform and complete the electrical work described in this Division. Apply for all permits early in the project to avoid problems due to code revisions.
- B. See the contract conditions (general and supplementary) and Division 1 for requirements concerning this Division including, but not limited to, submittals, shop drawings, substitution requests, change orders, maintenance manuals, record drawings, coordination, permits, record documents and guarantees.
- C. Division 26 Contractor shall be responsible for all work indicated by divisions 26, 27, 28, and the electrical portions of 33 within the drawings and specifications. Any work indicated by "Electrical" shall be provided and installed by the Division 26 Contractor.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

- A. Mechanical equipment motors to be furnished under another Division but connected under this Division. Starters shall be provided by this Division, unless otherwise noted on the electrical drawings. Verify and coordinate all equipment locations and electrical characteristics with other trades involved in the work. Coordination shall be done prior to rough-in or ordering equipment.
- B. Control wiring for mechanical equipment beyond provisions shown on the Electrical Drawings shall be performed under another Division of the work.

1.3 COORDINATION:

- A. Coordinate electrical connections to equipment:
 - 1. Refer to equipment manufacturer's shop drawings and written instructions. Provide all power and control wiring with associated raceways for complete operation.
 - 2. Where equipment is furnished with a cord and plug, provide receptacle to match equipment plug.
 - 3. Verify electrical requirements of equipment on nameplate and installation manual. Ensure that the electrical connections meet the requirements and notify Architect/Engineer of any discrepancies.
 - 4. Meet with equipment manufacturers representatives to coordinate equipment installation and electrical connections.

1.4 QUALITY ASSURANCE:

- A. Do all work in accordance with regulations of serving electric utility, telephone utility, cable TV utility, National Electrical Code, state and local codes and amendments, National Fire Codes, and all other applicable codes.

1.5 PROJECT CONDITIONS:

- A. The Contractor shall inspect the job site prior to bidding and familiarize himself with existing conditions which will affect the work. This project involves salvaged equipment to be reinstalled by the Contractor. As an alternative, contractor may provide new equipment. It is the Contractor's responsibility to visually inspect existing equipment prior to bidding. Prior to start of work, obtain "As built", "Record", or other Drawings showing existing underground utilities.
- B. Electrical drawings are diagrammatic indicating approximate location of outlets, lighting fixtures, electrical equipment, etc. Consult the Architectural, Structural, and Mechanical Drawings to avoid conflicts with equipment, structural members, etc. When required make all deviations from Drawings to make the work conform to the building as constructed, and to related work of others. Minor relocations ordered prior to installation may be made without added cost to Owner.
- C. Call to the attention of the Architect any error, omission, conflict or discrepancy in Drawings and/or Specifications. Do not proceed with any questionable items of work until clarification of same has been made.
- D. Under no conditions are beams, girders, footings or columns to be cut for electrical items unless so shown on Drawings or written approval obtained from the Architect.
- E. Verify the physical dimensions of each item of electrical equipment to fit the available space and promptly notify the Architect prior to roughing-in if conflicts appear. Coordination of equipment to the available space and to the access routes through the construction shall be the Contractor's responsibility.

1.6 SUBMITTALS AND SHOP DRAWINGS:

- A. In addition to Section 13300, "Submittal Procedures", comply with the following.
- B. Prior to ordering materials and equipment, the Contractor shall provide submittals in original, searchable PDF format, bookmarked with Section#, Product Name, ID tag, etc. Scanned pages will not be acceptable. Materials and equipment of each specification section shall be complete prior to submittal. Partial submittals will be marked "Incomplete" and returned for resubmittal.
- C. List shall bear Contractor's stamp, signature or other means to show that he has inspected same and certified that submitted material is correct in regard to quantity, size, dimension, quality and is coordinated with the Contract Documents.
- D. See individual sections within this Division for products requiring submittal.

- E. Each shop drawing submittal shall be prepared by the manufacturer, and shall clearly show manufacturer's name, catalog numbers, pictures, details, layout, type, size, rating, style, and all options identified in a permanent fashion. Specific items or options shall be permanently marked on sheets containing more than one option – do not rely on the Engineer to mark options.
- F. Large equipment drawings such as UPS systems, generators, transformers, switchboards, and similar large equipment shall include the size, weight, seismic rating, emissions data, elevation, and wiring diagrams in addition to the product data.
- G. Some sections of this Division may require shop drawings prepared on full size floor plans in AutoCAD or other CAD software. Where required, contact the Architect for the latest version of the floorplans and match the size and scale of the construction drawings. Drawings delivered to the contractor from the Architect/Engineer may not include addenda changes. Contractor shall only use floor plans for purposes of the construction on this job, and not for any other use or reuse. Add any required addenda items prior to finishing submittals.
- H. Provide complete materials (all materials) list at the beginning of each tabbed section showing "Specification Section", "Material Item", "Manufacturer's Name and Catalog Number", and all pertinent data.
- H. Provide samples where required in individual sections of this Division.
- I. Contractor agrees that Shop Drawing Submittals processed by the Architect are not Change Orders; that the purpose of Shop Drawing Submittals by the Contractor is to demonstrate to the Architect that the Contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use.
- J. Contractor further agrees that if deviations, discrepancies or conflicts between Shop Drawings and Specifications are discovered either prior to or after Shop Drawing Submittals are processed by the Architect, the design Drawings and Specifications shall control and shall be followed.
- K. Delays caused by contractor's neglect to submit on materials and equipment in time for Architect/Engineer's review, correction, resubmittal(s), shipment and delivery to the jobsite shall be the responsibility of the contractor.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. All materials shall be new and bear manufacturer's name, model number, electrical characteristics and other identification. All equipment to be U.L. approved or listed by another testing agency approved by authorities having jurisdiction.

- B. Material and equipment shall be standard product of manufacturer regularly engaged in production of similar material for at least five years (unless specifically exempted) and shall be manufacturer's latest design.
- C. If the description of a product is in conflict with the product as specified in the catalog number, the description shall generally take precedence. Contact the Architect for clarification if this occurs.
- D. All equipment shall be rated and certified for the appropriate seismic design category or seismic use group for the installed location.
- E. Provide access doors where required to maintain code-required access, or maintenance access, to equipment and wiring methods. Comply with Architectural division on Access Doors for requirements.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION METHODS:

- A. All items, articles, materials, and equipment specified under this Division shall be installed per the manufacturer's installation instructions. Where the manufacturer's instructions are in conflict with the directions provided elsewhere in this Contract, the Engineer shall be notified prior to beginning rough-in.
- B. Cutting or notching shall be kept to an absolute minimum and done when, and in a method approved by the Architect. Patch and correct finished surfaces damaged by electrical work.
- C. Relays, panels, cabinets and equipment shall be level and plumb and installed parallel with structural building lines. All equipment and enclosures shall fit neatly without gaps, openings, or distortions. Provide approved devices for closing all unused openings.
- D. Arrange circuit wiring as shown on the Drawings and do not alter or combine runs or homeruns without the specific approval of the Architect. Feeder runs shall not be recombined or altered.
- E. Contactors, transformers, starters and similar noise producing devices shall not be placed on walls which are common to occupied space.
- F. Ballasts, contactors, starters, transformers and like equipment which are found to be noticeably noisier than other similar equipment on the project will be deemed defective and shall be replaced.
- G. In general, the mounting heights shall be as noted on the Drawings, however, the Architectural Interior Elevations and drawing notes taking precedence. Where no heights are indicated, request clarification from the Architect. Consult the Architectural, Mechanical and Structural drawings to avoid conflicts prior to roughing-in and for exact locations.

- H. Where raceways penetrate floors, ceilings, ducts, chases, and fire walls, provide fire stopping to maintain integrity of the fire assembly. Firestopping method shall be approved by the Architect and Code Authority having jurisdiction.
- I. Maintain the following minimum separations from voice and data cables. Power conduit - 12", transformers and motors - 40", fluorescent lighting - 12". Coordinate with the voice and data installer to assure these separations are met.
- J. No underground excavating, digging, drilling, coring, sinking rods, driving spikes, or any work that would move grade-level earth will be started until a formal Blue Stake service has been requested and completed.

3.2 SAFETY:

- A. The Engineer has not been retained or compensated to provide design and construction review services relating to the Contractor's safety precautions or to means, methods, techniques, sequences or procedures required for the contractor to perform the work.

3.3 EQUIPMENT CONNECTIONS:

- A. The location and method for connecting to each item of equipment shall be verified prior to roughing-in. The voltage and phase of each item of equipment shall be checked before connecting. Motor rotations shall be made in the proper direction. Pump motors are not to be test run until liquid is in the system and proper lubrication to all bearings in unit is checked.
- B. Conduit, wire and circuit breaker sizes for mechanical, elevator and similar equipment are based on the equipment ratings of one manufacturer. The equipment actually furnished may have entirely different electrical characteristics. Conduit, wire, circuit breakers, disconnects, etc. shall not be ordered or installed until exact electrical requirements are obtained. Responsibility for this coordination rests with the Contractor.

3.4 ACCESS DOORS:

- A. Provide access doors to maintain access to equipment, junction boxes, cable trays, open wiring systems and other equipment requiring access. Install access doors in locations approved by the Architect. . Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

3.5 PAINTING:

- A. All electrical equipment and conduit exposed in finished areas and on exterior walls are to be painted in color according to Architect's instructions.
- B. Contractor shall coordinate the timing of painting requirements.
- C. Refer to Architectural specifications for methods and materials.

3.6 PROJECT RECORD DOCUMENTS:

A. Maintenance of Documents:

1. Maintain at Jobsite, One Record Copy of: Contract Drawings, Specifications, Addenda, Reviewed Shop Drawings, Change Orders, Other Modifications to Contract and Field Test Records.
2. Keep apart from documents used for construction.
3. Keep documents available at all times for inspection by Architect.

B. Recording:

1. Label each document "PROJECT RECORD."
2. Keep record documents current. Do not permanently conceal any work until required information has been recorded.
3. Contract Drawings, legibly mark to record actual construction; including but not limited to the following:
 - a. Depths of various elements; locations of underground items, with dimensions to building walls and corners; changes of dimensions and details; changes made by Addendum, Field Orders or Change Order.
 - b. Specifications and Addenda; legibly mark each Section to record changes made by Addendum, Field Order or Change Order.

C. As-Built Submittals:

1. At completion of project, transfer changes, addenda items, variations from drawings, exact routes of all feeders and service conduits, and locations of stubbed conduits to clean new prints and specifications which will be supplied by the Architect and deliver to the Architect as "As-reported Record" drawings. Include dimensions to all buried or concealed conduits to permanent structures.
2. Format for final as-built drawings shall be original PDF drawings, bookmarked per drawing sheet, marked up in PDF software such as Bluebeam. Scanned redline markups will not be acceptable.

D. Operation and Maintenance Manuals

1. At completion of project, prepare Operation and Maintenance Manuals with operation and Maintenance Data, contractors warranties, and copies of approved electrical permits. Include corrected copies of original submittals and shop drawings.
2. Manuals shall be in original, searchable PDF format, bookmarked with Section#, Product Name, ID tag, etc. Scanned pages will not be acceptable. Materials and

equipment of each specification section shall be complete prior to submittal. Partial submittals will be marked "Incomplete" and returned for resubmittal.

3. See Division 1 for additional requirements.

3.7 WARRANTIES:

- A. Provide a minimum 1 year warranty on all electrical equipment, devices, labor, and work by Division 26 whether specified or not.
- B. Provide warranties greater than 1 year as specified in other sections where stated. The warranty requirement most stringent shall be used where conflicts arise.
- C. Provide copies of all warranties to the owner upon completion of the project.

3.8 COMPLETION:

- A. Complete each system as shown or specified herein and place in operation except where only roughing-in or partial systems are called for. Each system shall be tested and left in proper operation free of faults, shorts or unintentional grounds. Demonstrate system in the presence of the Architect, the Owner or their representative when requested.

3.9 FINAL OBSERVATION:

- A. Contractor shall submit written certification that:
 1. Contract Documents have been reviewed.
 2. Contractor has inspected Project for compliance with Contract Documents.
 3. Work has been completed in accordance with Contract Documents.
 4. Equipment and Systems have been tested and are operational.
 5. Project is completed and ready for final inspection.
- B. Architect/Engineer will make final inspection as soon as possible after receipt of Certification.
- C. If additional inspections are required because of the Contractor's failure to complete the deficiencies and errors prior to the second inspection, costs for the successive inspections will be back-charged to the Contractor by the Owner, who, in turn, will reimburse the Architect. Charges will be based as follows:
 1. Architect/Engineer time at current billing rates.
 2. Travel time, and all other expenses incurred in making inspections.
- D. Contractor to provide one (1) journeyman, tools, meters, instruments and other test equipment required by Architect. Contractor to remove and replace trims, covers, fixtures, etc., for Architect to review and test materials, systems, methods and

workmanship. (Example: Removing switchboard and panel covers to take voltage/amp readings, review connections and wire size, etc.)

END OF SECTION 26000

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Building wire rated 600 V or less.
- 2. Connectors, splices, and terminations rated 600 V and less.

- B. Related Requirements:

- 1. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35,000 V.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Insulated Wire Corp.; a Leviton Company.
 - 2. Encore Wire Corporation
 - 3. Cerro Wire LLC.
 - 4. General Cable Technologies Corporation.
 - 5. Southwire Incorporated.
- C. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. RoHS compliant.
 - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 or ASTM B 496 (as applicable) for stranded conductors.
- E. Conductor Insulation:
 - 1. Type THWN-2: Comply with UL 83.
 - 2. Type XHHW-2: Comply with UL 44.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; a brand of the EGS Electrical Group.
 - 4. 3M; Electrical Markets Division.
 - 5. Tyco Electronics.
- C. Terminations for #6 wire and larger: Burndy "Qiklug" Type QDA, or approved equal, with round flange solderless lug, or connector on breaker (hex wrench or screw-type lug). Circuit wiring connections to fixture wire shall be made with pressure-type solderless connectors such as Buchanan, Scotchlok, Wire-Nut, or approved equal.

- D. For #6 wire and larger: Use Burndy type QPR, or approved equal. For #8 wire and smaller: Use Buchanan or equal pressure-type, solderless connectors complete with insulator and security ring or "PIGTAIL" splices as described below.
 - 1. Splices for small wires shall be "PIGTAIL" splices with separate tails of correct color and size. There shall be at least 6 inches of tail left out of box after splice is made up.
- E. No splicing for smoke or heat detection or other fire alarm panel-reporting devices. They must be directly connected to junction box (J-box) terminals or panel relay terminals.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 14 AWG and smaller; stranded for No. 12 AWG and larger.
- C. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THWN-2, single conductors in raceway.
- B. Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Branch Circuits: Type THHN/THWN-2, single conductors in raceway..
- D. Multi-Wire Branch Circuits: Install no more than three circuits in a raceway, unless indicated otherwise.
- E. Neutral Conductors: Provide one neutral conductor for each phase conductor. Shared neutral conductors are not allowed.
 - 1. Share neutral conductors are allowed only when multi-pole branch breakers are used to disconnect all phase conductors with a common neutral conductor, and shared neutral conductor is one size larger than the phase conductors.
- F. Minimum Branch Circuit Conductor Size: Provide the following minimum sizes for distances listed on 20A branch circuits to prevent excessive voltage drop. The circuit length shall be measured along the length of the conductor from the circuit breaker in the panelboard to the last device on the circuit. Increase raceway size to comply with conductor fill requirements of NFPA 70.
 - 1. Branch Circuit Voltage of 120V:
 - a. Circuit lengths less than 70 feet: Provide minimum #12 AWG conductor size.
 - b. Circuit lengths between 70 feet and 110 feet: Provide minimum #10 AWG conductor size.
 - c. Circuit lengths between 110 feet and 170 feet: Provide minimum #8 AWG conductor size.

- d. Circuit lengths greater than 170 feet: Perform voltage drop calculations and provide conductor size to keep branch circuit voltage drop less than 3% with a 15 amp load.
 2. Branch Circuit Voltage of 277V:
 - a. Circuit lengths less than 150 feet: Provide minimum #12 AWG conductor size.
 - b. Circuit lengths between 150 feet and 240 feet: Provide minimum #10 AWG conductor size.
 - c. Circuit lengths between 240 feet and 380 feet: Provide minimum #8 AWG conductor size.
 - d. Circuit lengths greater than 380 feet: Perform voltage drop calculations and provide conductor size to keep branch circuit voltage drop less than 3% with a 15 amp load.
 3. Non-Linear Loads: Conductors shall be minimum #10 AWG for 20A circuits feeding non-linear loads. Exception will be made for single-phase, non-linear lighting circuits.
- G. Fire Alarm Circuits:
1. Type THWN-2 in raceway for fire alarm power circuits, for horn circuits, and for strobe circuits.
 2. Power-limited, fire-protective, signaling circuit cable in raceway for initiating loop circuits.
 3. Twisted shielded pair in raceway for evacuation speakers.
 4. No splicing for smoke or heat detection or other fire alarm panel-reporting devices. They must be directly connected to junction box (J-box) terminals or panel relay terminals
- H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- I. VFC Output Circuits: Type TC-ER cable with braided shield.
- ### 3.3 INSTALLATION OF CONDUCTORS AND CABLES
- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
 - B. Install all conductors and cables in raceways per Section 260533, "Raceway and Boxes for Electrical Systems."
 - C. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
 - D. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 - E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

- F. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- G. Support cables not in raceway according to Section 260529 "Hangers and Supports for Electrical Systems."
- H. Do not bring conductors or cables into the back of any switchboard or panelboard.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least **6 inches (150 mm)** of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. Perform each of the following visual and electrical tests:

- a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
- a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
4. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
- C. Cables will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports to record the following:
1. Procedures used.
 2. Results that comply with requirements.
 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes grounding and bonding systems and equipment.
- B. Section includes grounding and bonding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Ground bonding common with lightning protection system.
 - 3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- 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.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with NFPA 70 for grounding and bonding of electrical systems.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. Dossert; AFL Telecommunications LLC.
3. ERICO International Corporation.
4. Fushi Copperweld Inc.
5. Galvan Industries, Inc.; Electrical Products Division, LLC.
6. Harger Lightning and Grounding.
7. ILSCO.
8. O-Z/Gedney; A Brand of the EGS Electrical Group.
9. Robbins Lightning, Inc.
10. Siemens Power Transmission & Distribution, Inc.
11. VFC, Inc.

2.3 CONDUCTORS

A. Insulated Conductors: Copper or tinned-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. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.
- E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- H. Conduit Hubs: Mechanical type, terminal with threaded hub.
- I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- J. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
- K. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.
- L. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.
- M. Straps: Solid copper, copper lugs. Rated for 600 A.
- N. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- O. Water Pipe Clamps:
 - 1. Mechanical type, two pieces with zinc-plated bolts.
 - a. Material: Tin-plated aluminum.
 - b. Listed for direct burial.
 - 2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; **3/4 inch by 10 feet (19 mm by 3 m)**.
- B. Ground Plates: **1/4 inch (6 mm)** thick, hot-dip galvanized.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 3/0 AWG minimum.
 - 1. Bury at least **36 inches (900 mm)** below grade.
 - 2. Duct-Bank Grounding Conductor: Bury **12 inches (300 mm)** above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical equipment rooms, telecommunication equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers **2 inches (50 mm)** minimum from wall, **6 inches (150 mm)** above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
- E. 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 AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so **4 inches (100 mm)** will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from **2 inches (50 mm)** above to **6 inches (150 mm)** below concrete. Seal floor opening with waterproof, nonshrink grout.

- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. 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 tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than **6 inches (150 mm)** from the foundation.

3.5 EQUIPMENT GROUNDING

- A. Install green insulated equipment grounding conductors in all raceways with feeders and branch circuits.
- B. 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.
- C. Water Heater, Heat-Tracing, and Antifrost 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.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- F. 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.
- G. Metallic Fences: Comply with requirements of IEEE C2.
 - 1. Grounding Conductor: Bare, tinned copper, not less than No. 6 AWG.
 - 2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
 - 3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.6 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 Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are **2 inches (50 mm)** 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 rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. 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 bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- E. 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; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by 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 metal piping systems including gas piping downstream from equipment shutoff valve.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

- G. 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 (18 m)** apart.
- H. Exposed Structural Metal: Bond exposed metal that is part of a building frame to the main building service grounding electrode system.
- I. 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.
 - 1. Install tinned-copper conductor not less than No. 3/0 AWG for ground ring and for taps to building steel.
 - 2. Bury ground ring not less than **36 inches (900 mm)** from building's foundation.
- J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of **20 feet (6 m)** of bare copper conductor not smaller than No. 4 AWG.
 - 1. If concrete foundation is less than **20 feet (6 m)** long, coil excess conductor within base of foundation.
 - 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and 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.
 - 4. 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.

- E. Grounding system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 - 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 - 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 - 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
 - 5. Substations and Pad-Mounted Equipment: 5 ohms.
 - 6. Manhole Grounds: 10 ohms.
- H. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

- B. Related Requirements:

- 1. Section 260548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

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 the following:
 - a. Hangers.
 - b. Steel slotted support systems.
 - c. Nonmetallic support systems.
 - d. Trapeze hangers.
 - e. Clamps.
 - f. Turnbuckles.
 - g. Sockets.
 - h. Eye nuts.
 - i. Saddles.
 - j. Brackets.
 - 2. Include rated capacities and furnished specialties and accessories.

- B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

- 1. Trapeze hangers. Include product data for components.
 - 2. Steel slotted-channel systems.
 - 3. Nonmetallic slotted-channel systems.

4. Equipment supports.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Suspended ceiling components.
 2. Structural members to which hangers and supports will be attached.
 3. Size and location of initial access modules for acoustical tile.
 4. Items penetrating finished ceiling, including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Projectors.
- B. Seismic Qualification Certificates: For hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 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.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M.
 2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.

- B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
 2. Component Importance Factor: 1.5 raceways and equipment connected to an emergency/standby system; 1.0 for other raceways and equipment.
- C. 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 Rating: Class 1.
 2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.
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. Allied Tube & Conduit; a part of Atkore International.
 - b. B-line, an Eaton business.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation; A Member of the ABB Group.
 - f. Unistrut; Part of Atkore International.
 2. Material: Galvanized steel.
 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 4. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 5. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems unless requirements in this Section are stricter.
- B. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be **1/4 inch (6 mm)** in diameter.
- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- E. Spring-steel clamps designed for supporting single conduits without bolts may be used for **1-1/2-inch (38-mm)** and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus **200 lb (90 kg)**.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners
 - 5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts Beam, clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69 [**Spring-tension clamps**].
 - 6. To Light Steel: Sheet metal screws.
 - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.
- E. Powder-driven fasteners (and shot pin) is strictly prohibited.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than **4 inches (100 mm)** larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

- B. Use **3000-psi (20.7-MPa)**, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of **2.0 mils (0.05 mm)**.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Surface raceways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

- B. Related Requirements:

1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.
- B. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 1. Structural members in paths of conduit groups with common supports.

2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 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.
 4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
- C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. AFC Cable Systems, Inc.
 2. Alflec 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. O-Z Gedney; a unit of General Signal.
 9. Wheatland Tube Company.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. IMC: Not permitted.
- E. Aluminum Conduit: Not permitted.
- F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
1. Comply with NEMA RN 1.
 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- G. EMT: Comply with ANSI C80.3 and UL 797.
- H. FMC: Comply with UL 1; zinc-coated steel.

- I. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- J. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Setscrew or compression.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 - 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of **0.040 inch (1 mm)**, with overlapping sleeves protecting threaded joints.
- K. Joint Compound for IMC, GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Anamet Electrical, Inc.
 - 3. Aruco Corporation.
 - 4. CANTEX Inc.
 - 5. CertainTeed Corp.
 - 6. Condux International, Inc.
 - 7. ElecSYS, Inc.
 - 8. Electri-Flex Company.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Niedax-Kleinhuis USA, Inc.
 - 11. RACO; a Hubbell company.
 - 12. Thomas & Betts Corporation.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 or Type 3R as required, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, 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.
- C. Wireway Covers: Screw-cover type unless otherwise indicated.
- D. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.5 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. MonoSystems, Inc.

- c. Wiremold / Legrand.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
- D. Metal Floor Boxes:
 - 1. Material: Cast metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Nonmetallic Floor Boxes: Nonadjustable, rectangular.
 - 1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- I. Minimum Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).
- J. Gangable boxes are allowed.
- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 3R as required by location, with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Fiberglass.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- L. Cabinets:

1. NEMA 250, Type 1 or Type 3R as required by location galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with closed bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC" or "COMMUNICATIONS" as required by service type.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes **12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long)** and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.8 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. Tests of materials shall be performed by an independent testing agency.
2. 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.
3. 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 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC.
 2. Concealed Conduit, Aboveground: GRC.
 3. Underground Conduit: RNC, Type EPC-40-PVC, concrete encased.
 - a. Provide wrapped rigid steel conduit for the following conditions. Wrap shall be 2 layers of 20-mil rubber tape.
 - 1) Penetrations through foundation walls.
 - 2) Bends greater than 22 degrees.
 - 3) Stub ups, or where underground conduits otherwise become exposed.
 - b. Minimum Radius of bends and sweeps:
 - 1) 2" – 2-1/2" Diameter: 36-inch radius.
 - 2) 3" – 5" Diameter: 48-inch radius.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC in lengths not to exceed 6'.
 5. Connections to suspended light and lay-in lights in suspended ceilings: 3/8" factory whips in lengths not to exceed 6'.
 6. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT for 2" dia. and smaller, GRC for 2-1/2" and larger.
 2. Exposed and Subject to Physical Damage: GRC. Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 5. Damp or Wet Locations: GRC.
 6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
 7. Above 600V: GRC.
- C. Minimum Raceway Size: 3/4-inch (21-mm) trade size for above-ground installations; 1-inch trade size for underground installations.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz.
- F. Install surface raceways only where indicated on Drawings.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Conceal raceways in ceilings and walls unless reviewed and approved by Architect/Engineer.
- C. Install raceways parallel and perpendicular to building walls and ceilings.
- D. Keep raceways at least **6 inches (150 mm)** away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- E. Complete raceway installation before starting conductor installation.
- F. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within **12 inches (300 mm)** of changes in direction.
- I. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- J. Support conduit within **12 inches ((300 mm))** of enclosures to which attached.
- K. Raceways Embedded in Slabs on Grade:
1. In office and academic buildings, raceways are not allowed to be installed in concrete slabs.
 2. Where allowed, PVC can be placed in a concrete slab on grade as long as the conduit is embedded in a slab that is minimum 6 inch thick. No conduit shall be placed between the reinforcing steel and the bottom of the slab.

3. Run conduit larger than **1-inch (27-mm)** trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum **10-foot ((3-m))** intervals.
 4. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 5. Arrange raceways to keep a minimum of **1 inch (25 mm)** of concrete cover in all directions.
 6. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 7. Change from PVC to GRC before rising above floor.
- L. Do not install conduits embedded in elevated slabs.
- M. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for raceways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to **1-1/4-inch (35mm)** trade size and insulated throat metal bushings on **1-1/2-inch (41-mm)** trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- S. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- T. Do not bring raceways into the back of any switchboard or panelboard.
- U. Cut conduit perpendicular to the length. For conduits **2-inch (53-mm)** trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- V. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than **200-lb (90-kg)** tensile strength. Leave at least **12 inches (300 mm)** of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

- W. Provide all necessary sleeves and chases required where conduits pass through floors or walls. All sleeves shall be fire-sealed in accordance with the fire rating of the wall or floor, and finish to match adjacent surfaces.
- X. Surface Raceways:
1. Install surface raceway with a minimum **2-inch (50-mm)** radius control at bend points.
 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding **48 inches (1200 mm)** and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- Y. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- Z. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- AA. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- BB. Expansion-Joint Fittings:
1. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed **100 deg F (55 deg C)** and that has straight-run length that exceeds **100 feet (30 m)**.
 2. Install fitting(s) that provide expansion and contraction for at least **0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C)** of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least **0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C)** of temperature change for metal conduits.
 3. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 4. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- CC. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of **72 inches (1830 mm)** of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.

- DD. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, comply with ADA requirements and refer to Architectural elevations.
- EE. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- FF. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- GG. Locate boxes so that cover or plate will not span different building finishes.
- HH. Support all device boxes from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- II. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- JJ. Set metal floor boxes level and flush with finished floor surface.
- KK. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Conduit and Raceways:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than **6 inches (150 mm)** in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within **12 inches (300 mm)** of finished grade, make final conduit connection at end of run and complete backfilling to 95% compaction.
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with **3 inches (75 mm)** of concrete for a minimum of **12 inches (300 mm)** on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of **60 inches (1500 mm)** from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately **12 inches (300 mm)** above direct-buried conduits but a minimum of **6 inches (150 mm)** below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 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 (12.5-mm)** sieve to **No. 4 (4.75-mm)** 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 (25 mm)** above finished grade.
- D. Install handholes with bottom below frost line, below grade.
- 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 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.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

- B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; **0.0239-inch (0.6-mm)** minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors **2 inches (50 mm)** above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Provide conduit sleeves in all floor-to-structure walls for the installation of all conduits that pass through wall. Sleeves shall be 4" for installation of data cabling. Install fire stop at all rated walls matching the walls rating.
- C. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 26 0548

SEISMIC CONTROLS 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Restraint channel bracings.
 - 2. Restraint cables.
 - 3. Seismic-restraint accessories.
 - 4. Mechanical anchor bolts.
 - 5. Adhesive anchor bolts.
- B. Related Requirements:
 - 1. Section 26 0529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Delegated-Design Submittal: For each seismic-restraint device.
 - 1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic and wind forces required to select seismic and wind restraints and for designing vibration isolation bases.

- a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
3. Seismic-Restraint Details:
- a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- C. Deferred Submittals for the Authority Having Jurisdiction (AHJ) shall be as required by IBC 106.3.4.2.
1. Deferred submittals of seismic restraint of nonstructural components must be submitted to the AHJ a minimum of two weeks prior to the planned installation in order to allow for plan review and forwarding to inspectors. In the event that the submittal is deficient additional time may become necessary.
 2. No deferred submittal element shall be installed until AHJ approval has been received.
 3. If seismic restraints of nonstructural components are installed prior to receiving AHJ approval they shall not be covered or concealed until plan review and inspection approval. Further, installers are proceeding at their own risk until plan review and inspection approval occurs.
 4. Deferred Submittals are required for:
 - a. Electrical distribution equipment (switchboards, panelboards, transformers, MCC's etc.).
 - b. Generators, batteries, UPS.
 - c. Conduit racks.
 - d. Cable trays.
 - e. Lighting fixtures.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- B. Qualification Data: For professional engineer.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC and ASCE 7 unless requirements in this Section are more stringent.

- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD in addition to preapproval, showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- D. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Provisions for Required Design & Anchorage Forces for Nonstructural Elements, Systems & Components for Base Isolated Building:
 - 1. Design and anchorage for nonstructural elements and components may follow the provisions of ASCE 7-16 Section 13.3.1.1 & 13.3.1.1.2, utilizing the S_{ds} factor for the site as a fixed base building ($S_{ds}=1.17$).
 - 2. Alternate provisions for design and anchorage of nonstructural elements may be utilized following the provisions of ASCE 7-16 Section 13.3.1.4 (Equation 13.3-4) with horizontal accelerations (a_i) taken from the following table:

Story	a_i (g)
N00	0.24
N01	0.23
N02	0.21
N03	0.23
N04	0.26
Penthouse Floor (roof)	0.31
Penthouse Roof	0.32

- The value for F_p (minimum design force) shall not taken as less than $0.3S_{ds}I_pW_p$ where S_{ds} represents the spectral design acceleration for short periods at the site ($S_{ds}=1.17$). F_p need not be taken greater than $1.6S_{ds}I_pW_p$. The torsional amplification factor (A_x) may be taken as 1.0. Vertical seismic forces shall be presumed to act concurrently with the horizontal forces derived above in accordance with ASCE 7-16 Section 13.3.1.2.
- 3. The Overstrength Factor (Ω_0) shall be applied to F_p design forces in accordance with ASCE 7-16 provisions regardless of the method used to determine F_p design forces.

2.2 RESTRAINT CHANNEL BRACINGS

- A. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.3 RESTRAINT CABLES

- A. Restraint Cables: ASTM A 603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.4 SEISMIC-RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.5 MECHANICAL ANCHOR BOLTS

- A. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.6 ADHESIVE ANCHOR BOLTS

- A. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 3053 "Miscellaneous Cast-in-Place Concrete."
- B. Equipment and Hanger Restraints:
 - 1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 - 2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- F. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to 90 percent of rated proof load of device.
- C. Seismic controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 SPECIAL INSPECTION

- A. Per the requirements of ASCE 7, the building owner will employ a special inspector(s) to observe the construction of all Designated Seismic Systems in accordance with the Quality Assurance Plan.
- B. Special inspection for electrical components shall be as follows:
 - 1. Periodic special inspection during the anchorage of electrical equipment for emergency and standby power systems, including but not limited to:
 - a. Generator systems.
 - b. Emergency and standby power distribution equipment, wiring and raceways.
 - c. Emergency lighting, with associated conduit, wiring and distribution system.
 - d. Fire alarm system and devices, with associated conduit, wiring and distribution system.
 - e. Uninterruptible Power Systems with associated distribution equipment, conduit and wiring.
 - f. Pendant light fixtures, where pendant length exceeds 24".

END OF SECTION 26 0548.16

SECTION 260553 - IDENTIFICATION 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

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 electrical identification products.

- B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.

- E. Comply with NFPA 70E requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
 - 1. Color for wire and cable #8 AWG and smaller shall have color-coded insulation or jacketing as noted below. For sizes #6 and larger, colored tape may be used in lieu of factory applied colors. Apply tape at all terminations, loops, splices and boxes.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 3. Colors for 240-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - 4. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - 5. Color for Neutral: White for 120/208V systems; gray for 277/480V systems.
 - 6. Color for Equipment Grounds: Green.
 - 7. Colors for Isolated Grounds: Green with white stripe.
- B. Raceways and Cables Carrying Circuits at More Than 600 V:
 - 1. Black letters on a red field.
 - 2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."
- C. Warning Label Colors:
 - 1. Identify system voltage with black letters on an orange background.
- D. Warning labels and signs shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
- B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
- C. Self-Adhesive Wraparound Labels: Preprinted, **3-mil- (0.08-mm-)** thick, polyester flexible label with acrylic pressure-sensitive adhesive.
 - 1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
 - 2. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 3. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Polyester, thermal, transfer-printed, **3-mil- (0.08-mm-)** thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 1. Minimum Nominal Size:
 - a. **1-1/2 by 6 inches (37 by 150 mm)**for raceway and conductors.
 - b. **3-1/2 by 5 inches (76 by 127 mm)**for equipment.
 - c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

- A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, **2 inches (50 mm)** long, with diameters sized to suit diameters and that stay in place by gripping action.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of **200 deg F (93 deg C)**. Comply with UL 224.

2.5 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than **3 mils (0.08 mm)** thick by **1 to 2 inches (25 to 50 mm)** wide; compounded for outdoor use.
- C. Tape and Stencil: **4-inch- (100-mm-)** wide black stripes on **10-inch (250-mm)** centers placed diagonally over orange background and is **12 inches (300 mm)** wide. Stop stripes at legends.

- D. Floor Marking Tape: **2-inch- (50-mm-)** wide, **5-mil (0.125-mm)** pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
- E. Underground-Line Warning Tape:
1. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 2. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
 3. Type:
 - a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: **3 inches (75 mm)**.
 - c. Overall Thickness: **5 mils (0.125 mm)**.
 - d. Foil Core Thickness: **0.35 mil (0.00889 mm)**.
 - e. Weight: **28 lb/1000 sq. ft. (13.7 kg/100 sq. m)**.
 - f. Tensile according to ASTM D 882: **70 lbf (311.3 N)** and **4600 psi (31.7 MPa)**.
- F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be **1 inch (25 mm)**.

2.6 TAGS

- A. Metal Tags: Brass or aluminum, **2 by 2 by 0.05 inch (50 by 50 by 1.3 mm)**, with stamped legend, punched for use with self-locking cable tie fastener.
- B. Nonmetallic Preprinted Tags: Polyethylene tags, **0.023 inch (0.58 mm)** thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.
- C. Write-on Tags:
1. Polyester Tags: **0.015 inch (0.38 mm)** thick, with corrosion-resistant grommet and cable tie for attachment.

2. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
3. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 SIGNS

A. Baked-Enamel Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. **1/4-inch (6.4-mm)** grommets in corners for mounting.
3. Nominal Size: **7 by 10 inches (180 by 250 mm)**.

B. Metal-Backed Butyrate Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with **0.0396-inch (1-mm)** galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
2. **1/4-inch (6.4-mm)** grommets in corners for mounting.
3. Nominal Size: **10 by 14 inches (250 by 360 mm)**.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.
2. Thickness:
 - a. For signs up to **20 sq. in. (129 sq. cm)**, minimum **1/16 inch (1.6 mm)** thick).
 - b. For signs larger than **20 sq. in. (129 sq. cm)**, **1/8 inch (3.2 mm)** thick.
 - c. Engraved legend with white letters on a dark gray background.
 - d. Punched or drilled for mechanical fasteners with **1/4-inch (6.4-mm)** grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: **3/16 inch (5 mm)**.
2. Tensile Strength at **73 Deg F (23 Deg C)** according to ASTM D 638: **12,000 psi (82.7 MPa)**.
3. Temperature Range: **Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**.
4. Color: Black, except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D 638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.

- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum **3/8-inch- (10-mm-)** high letters for emergency instructions at equipment used for power transfer.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY POWER."
 - 2. "POWER."
 - 3. "UPS."
- M. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- P. Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide a single line of text with **1/2-inch- (13-mm-)** high letters on **1-1/2-inch- (38-mm-)** high label; where two lines of text are required, use labels **2 inches (50 mm)** high.

- Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
 - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of **6 inches (150 mm)** where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- W. Underground Line Warning Tape:
 - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at **6 to 8 inches (150 to 200 mm)** below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds **16 inches (400 mm)** overall.
 - 2. Install underground-line warning tape for direct-buried cables and cables in raceways.
- X. Metal Tags:
 - 1. Place in a location with high visibility and accessibility.
 - 2. Secure using UV-stabilized cable ties.
- Y. Nonmetallic Preprinted Tags:
 - 1. Place in a location with high visibility and accessibility.
 - 2. Secure using UV-stabilized cable ties.
- Z. Write-on Tags:
 - 1. Place in a location with high visibility and accessibility.
 - 2. Secure using UV-stabilized cable ties.
- AA. Baked-Enamel Signs:
 - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 - 2. Unless otherwise indicated, provide a single line of text with **1/2-inch- (13-mm-)** high letters on minimum **1-1/2-inch- (38-mm-)** high sign; where two lines of text are required, use signs minimum **2 inches (50 mm)** high.

BB. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with **1/2-inch- (13-mm-)** high letters on **1-1/2-inch- (38-mm-)** high sign; where two lines of text are required, use labels **2 inches (50 mm)** high.

CC. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with **1/2-inch- (13-mm-)** high letters on **1-1/2-inch- (38-mm-)** high sign; where two lines of text are required, use labels **2 inches (50 mm)** high.

DD. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with **3-inch- (75-mm-)** high, black letters on **20-inch (500-mm)** centers.
1. Locate identification at changes in direction, at penetrations of walls and floors, and at **10-foot (3-m)** maximum intervals.
- D. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Vinyl wraparound labels.
1. Locate identification at changes in direction, at penetrations of walls and floors, at **50-foot (15-m)** maximum intervals in straight runs, and at **25-foot (7.6-m)** maximum intervals in congested areas.
- E. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.
1. Locate identification at changes in direction, at penetrations of walls and floors, at **50-foot (15-m)** maximum intervals in straight runs, and at **25-foot (7.6-m)** maximum intervals in congested areas.

- F. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
1. "EMERGENCY POWER."
 2. "POWER."
 3. "UPS."
 4. "FIRE ALARM"
- G. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive wraparound labels to identify the phase.
1. Locate identification at changes in direction, at penetrations of walls and floors, at **50-foot (15-m)** maximum intervals in straight runs, and at **25-foot (7.6-m)** maximum intervals in congested areas.
- H. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.
- I. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.
- J. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.
- K. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- L. Auxiliary Electrical Systems Conductor Identification: Marker tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- M. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- N. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:
1. Floor surface directly above conduits running beneath and within **12 inches (300 mm)** of a floor that is in contact with earth or is framed above unexcavated space.
 2. Wall surfaces directly external to raceways concealed within wall.
 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- O. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and

29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

- P. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- Q. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.
 - 1. Apply to exterior of door, cover, or other access.
 - 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.
- R. Arc Flash Warning Labeling: Self-adhesive labels.
- S. Operating Instruction Signs: Self-adhesive labels.
- T. Emergency Operating Instruction Signs: Laminated acrylic or melamine plastic signs with white legend on a red background with minimum **3/8-inch- (10-mm-)** high letters for emergency instructions at equipment used for power transfer.
- U. Equipment Identification Labels: Nameplate material shall be 3/32 inches thick engraved, laminated plastic or Micarta type with white letters engraved through the black background, except on emergency systems - background shall be red and include the word "EMERGENCY." Letters shall be 3/16 inches high for devices, and minimum 1/2 inch-high for equipment and enclosures. Nameplates shall be mechanically secured with self-tapping screws, bolts or rivets. Adhesives are not acceptable
 - 1. Indoor and Outdoor Equipment: Laminated acrylic or melamine plastic sign.
 - 2. Outdoor Equipment: Laminated acrylic or melamine sign.
 - 3. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - 4. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 - 5. Color Coding of Labels: Identify branch of electrical system by coloring coding the labels
 - a. Equipment Connected to Normal Power: White lettering on black background.
 - b. Equipment Connected to Emergency (life-safety) Power: White lettering on red background.
 - c. Equipment Connected to Stand-by(optional) Power: Red lettering on white background.
 - d. Equipment Connected to UPS Power, "A" system: White lettering on orange background.
 - e. Equipment Connected to UPS Power, "B" system: White lettering on blue background.
 - f. Equipment Connected to UPS Power, non-redundant office system: Orange lettering on white background
 - 6. Identify source bus, voltage and location feeding the equipment, for example:

PANEL 3LBA
120/208V 3-PHASE 4-WIRE
FED FROM 3LDPB
ROOM #1003

7. Equipment to Be Labeled:
- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets including: new, existing, & salvaged-reinstalled.
 - c. Access doors and panels for concealed electrical items including: new, existing, & salvaged-reinstalled.
 - d. Switchgear including: new, existing, & salvaged-reinstalled.
 - e. Switchboards including: new, existing, & salvaged-reinstalled.
 - f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary including: new, existing, & salvaged-reinstalled.
 - g. Substations.
 - h. Emergency system boxes and enclosures including: new, existing, & salvaged-reinstalled.
 - i. Motor-control centers including: new, existing, & salvaged-reinstalled.
 - j. Enclosed switches including: new, existing, & salvaged-reinstalled.
 - k. Enclosed circuit breakers including: new, existing, & salvaged-reinstalled.
 - l. Enclosed controllers including: new, existing, & salvaged-reinstalled.
 - m. Variable-speed controllers including: new, existing, & salvaged-reinstalled.
 - n. Push-button stations including: new, existing, & salvaged-reinstalled.
 - o. Power-transfer equipment.
 - p. Contactors.
 - q. Remote-controlled switches, dimmer modules, and control devices including: new, existing, & salvaged-reinstalled.
 - r. Battery-inverter units including: new, existing, & salvaged-reinstalled.
 - s. Battery racks.
 - t. Power-generating units.
 - u. Monitoring and control equipment.
 - v. UPS equipment.

END OF SECTION 260553

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE STUDY

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 computer-based, overcurrent protective device studies to determine the following:
 1. The minimum interrupting capacity of circuit protective devices
 2. Overcurrent protective device settings for selective tripping.
 3. The arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form; signed, dated and sealed by a qualified professional engineer.
 1. Short-circuit study input data, including completed computer program input data sheets.
 2. Coordination-study input data, including completed computer program input data sheets.
 3. Arc-flash study report.

- a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Coordination Study Specialist.
- B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. The following parts from the Protective Device Coordination Study Report:
 - 1) One-line diagram.
 - 2) Protective device coordination study.
 - 3) Time-current coordination curves.
 - b. Power system data.
 2. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.

1.7 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 unacceptable.
- B. Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of

the study shall be performed under the direct supervision and control of this professional engineer.

- D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Software Developers:

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. SKM Systems Analysis, Inc.

B. Comply with IEEE 242 and IEEE 399.

C. Comply with IEEE 1584 and NFPA 70E.

D. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

E. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:

- a. Arcing faults.
- b. Simultaneous faults.
- c. Explicit negative sequence.
- d. Mutual coupling in zero sequence.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
 2. Cable size and lengths.
 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 4. Motor and generator designations and kVA ratings.
 5. Switchgear, switchboard, motor-control center, and panelboard designations.
- D. Comments and recommendations for system improvements, where needed.
- E. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
 3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- F. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.
- G. Short-Circuit Study Output:
1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Equivalent impedance.
 2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.
 3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.

- b. Calculated symmetrical fault-current magnitude and angle.
- c. Fault-point X/R ratio.
- d. No AC Decrement (NACD) ratio.
- e. Equivalent impedance.
- f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
- g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

2.3 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."
- F. Protective Device Coordination Study:
 - 1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
 - a. Phase and Ground Relays:
 - 1) Device tag.
 - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - 3) Recommendations on improved relaying systems, if applicable.
 - b. Circuit Breakers:
 - 1) Adjustable pickups and time delays (long time, short time, ground).
 - 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.
 - c. Fuses: Show current rating, voltage, and class.

- G. Time-Current Coordination Curves: 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:
1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
 2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
 3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
 4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Medium-voltage equipment overcurrent relays.
 - c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - f. Cables and conductors damage curves.
 - g. Ground-fault protective devices.
 - h. Motor-starting characteristics and motor damage points.
 - i. Generator short-circuit decrement curve and generator damage point.
 - j. The largest feeder circuit breaker in each motor-control center and panelboard.
 5. Series rating on equipment allows the application of two series interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Both devices share in the interruption of the fault and selectivity is sacrificed at high fault levels. Maintain selectivity for tripping currents caused by overloads.
 6. Provide adequate time margins between device characteristics such that selective operation is achieved.
 7. Comments and recommendations for system improvements.

2.4 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope.
- C. One-line diagram, showing the following:
 1. Protective device designations and ampere ratings.
 2. Cable size and lengths.
 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 4. Motor and generator designations and kVA ratings.
 5. Switchgear, switchboard, motor-control center and panelboard designations.

- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output: As specified in "Short Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."
- F. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."
- G. Arc-Flash Study Output:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- H. Incident Energy and Flash Protection Boundary Calculations:
 - 1. Arcing fault magnitude.
 - 2. Protective device clearing time.
 - 3. Duration of arc.
 - 4. Arc-flash boundary.
 - 5. Working distance.
 - 6. Incident energy.
 - 7. Hazard risk category.
 - 8. Recommendations for arc-flash energy reduction.
- I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

2.5 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a **3.5-by-5-inch (76-by-127-mm)** self-adhesive equipment label for each work location included in the analysis.
- B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
 - 1. Location designation.
 - 2. Nominal voltage.

3. Flash protection boundary.
4. Hazard risk category.
5. Incident energy.
6. Working distance.
7. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

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.
- B. Obtain all data necessary for the conduct of the study.
 1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Architect.
 2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
- C. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.
- D. Gather and tabulate the following input data to support coordination study. The list below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
 1. Product Data for overcurrent protective devices specified in other 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. Electrical power utility impedance at the service.
 3. Power sources and ties.
 4. Short-circuit current at each system bus, three phase and line-to-ground.
 5. Full-load current of all loads.
 6. Voltage level at each bus.

7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
 10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
 12. Maximum demands from service meters.
 13. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
 14. Motor horsepower and NEMA MG 1 code letter designation.
 15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
 16. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.
 17. 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 SCCR in amperes rms symmetrical.
- E. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements

3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.

- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is indicated on Drawings.
- E. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices as follows:
 - 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 - 2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 75 kVA.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:
 - 1. Electric utility's supply termination point.
 - 2. Incoming switchgear.
 - 3. Unit substation primary and secondary terminals.
 - 4. Low-voltage switchgear.
 - 5. Motor-control centers.
 - 6. Control panels.
 - 7. Standby generators and automatic transfer switches.
 - 8. Branch circuit panelboards.
 - 9. Disconnect switches.

3.3 PROTECTIVE DEVICE COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. The study shall be based on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is indicated on Drawings.
- E. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.
 2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 75 kVA.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. 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.
- H. Motor Protection:
1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
 2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
- I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations 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.
- J. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.
- K. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:
1. Electric utility's supply termination point.
 2. Switchgear.
 3. Unit substation primary and secondary terminals.
 4. Low-voltage switchgear.

5. Motor-control centers.
6. Standby generators and automatic transfer switches.
7. Branch circuit panelboards.

M. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.

3.4 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies:

1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" above.
2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" above.

C. Calculate maximum and minimum contributions of fault-current size.

1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except equipment rated 240-V ac or less fed from transformers less than 75 kVA.

F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

- H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:
 - 1. When the circuit breaker is in a separate enclosure.
 - 2. When the line terminals of the circuit breaker are separate from the work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.5 LABELING

- A. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:
 - 1. Motor-control centers.
 - 2. Low-voltage switchboards and panelboards.
 - 3. Switchgear.
 - 4. Medium-voltage switch.
 - 5. Control panel.

3.6 APPLICATION OF WARNING LABELS

- A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.7 FIELD ADJUSTING

- A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
- B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.
- C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.8 DEMONSTRATION

- A. Engage the Coordination Study Specialist to train Owner's maintenance personnel in the following:
 - 1. Acquaint personnel in the fundamentals of operating the power system in normal and emergency modes.

2. Hand-out and explain the objectives of the coordination study, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting the time-current coordination curves.
3. Adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION 260573

SECTION 26 0923
DIGITAL LIGHTING CONTROL SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Digital Lighting and Plug Load Controls
 - 2. Relay Panels
 - 3. Emergency Lighting Control (if applicable)
- B. Related Sections:
 - 1. Section 26 2726 - Wiring Devices Receptacles
 - 2. Section 26 5113 – Interior Lighting Fixtures, Lamps, and Ballasts Fluorescent electronic dimming ballasts.
- C. Control Intent – Control Intent includes, but is not limited to:
 - 1. Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
 - 2. Initial sensor and switching zones
 - 3. Initial time switch settings
 - 4. Emergency Lighting control (if applicable)

1.2 REFERENCES

- A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) (www.ansi.org and www.ieee.org)
- B. International Electrotechnical Commission (IEC) (www.iec.ch)
- C. International Organization for Standardization (ISO) (www.iso.ch):
- D. National Electrical Manufacturers Association (NEMA) (www.nema.org)
- E. WD1 (R2005) - General Color Requirements for Wiring Devices.
- F. Underwriters Laboratories, Inc. (UL) (www.ul.com):
 - 1. 20 – Plug Load Controls
 - 2. 508 – Industrial Controls
 - 3. 916 – Energy Management Equipment
 - 4. 924 – Emergency Lighting
- G. Underwriter Laboratories of Canada (ULC) (www.ulc.ca)

1.3 SYSTEM DESCRIPTION & OPERATION

- A. The Lighting Control and Automation system as defined under this section covers the following equipment:
 - 1. Digital Lighting Management local network – Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
 - 2. Digital Room Controllers – Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring capabilities.

3. Digital Plug Load Controllers – Self-configuring, digitally addressable, single relay, plenum-rated application-specific controllers. Selected models include integral current monitoring capabilities.
4. Digital Fixture Controllers – Self-configuring, digitally addressable one relay fixture-integrated controllers for on/off/0-10V dimming control.
5. Digital Occupancy Sensors – Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
6. Digital Switches – Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.
7. Handheld remotes for personal control – On/Off, dimming and scene remotes for control using infrared (IR) communications. Remote may be configured in the field to control selected loads or scenes without special tools.
8. Digital Daylighting Sensors – Single-zone closed loop, multi-zone open loop and single-zone dual-loop daylighting sensors with two-way active infrared (IR) communications for daylight harvesting using switching, bi-level, tri-level or dimming control.
9. Configuration Tools – Handheld remote for room configuration and relay panel programming provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away.
10. Digital Lighting Management segment network – Linear topology, BACnet MS/TP network (1.5 twisted pair, shielded) to connect multiple local networks for centralized control.
11. Network Bridge – Provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS) and automatically creates BACnet objects representative of connected devices.
12. Segment Manager – BACnet MS/TP-based controller with web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
13. Programming and Configuration Software – Optional PC-native application capable of accessing control parameters within a room, for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication.
14. Digital Lighting Management Relay Panel and Zone Controller – Provides up to 8, 24, or 48 mechanically latching relays. Relays include a manual override and a single push-on connector for easy installation or removal from the panel. Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP-compliant digital networked communication between other lighting controls and/or building automation system (BAS). Zero relay Zone Controller primarily supports Digital Fixture Controller applications.
15. Emergency Lighting Control Unit– Allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building

1.4 LIGHTING CONTROL APPLICATIONS

- A. Unless relevant provisions of the applicable local energy codes are more stringent, provide a minimum application of lighting controls as follows:

1. Space Control Requirements – Provide occupancy/vacancy sensors with Manual- or Partial-ON functionality in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and Automatic-ON occupancy sensors are more appropriate. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room. For spaces with multiple occupants, or where line-of-sight may be obscured, provide ceiling- or corner-mounted sensors and Manual-ON switches.
2. Task Lighting / Plug Loads – Provide automatic shut off of non essential plug loads and task lighting in all spaces except toilet rooms and storerooms. Provide Automatic-ON of plug loads whenever spaces are occupied. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area.
3. Daylit Areas – Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) where daylight contribution is available as defined by relevant local building energy code:
 - a. All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylit zones.
 - b. Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes.
 - c. Multiple-level switched daylight harvesting controls may be utilized for areas marked on drawings.
 - d. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.
4. Conference, meeting, training, auditoriums, and multipurpose rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four preset lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to turn off all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.

1.5 SUBMITTALS

- A. Submittals Package: Submit the shop drawings, and the product data specified below at the same time as a package.
- B. Shop Drawings:
 1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed.
 2. Show exact location of all digital devices, including at minimum sensors, sensor coverage patterns, load controllers, and switches for each area on reflected ceiling plans. (Contractor must provide AutoCAD format reflected ceiling plans.)
 3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
 4. Network riser diagram including floor and building level details. Include network cable specification and end-of-line termination details, if required.

Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.

- C. Product Data: Catalog sheets, specifications and installation instructions.
- D. Include data for each device which:
 - 1. Indicates where sensor is proposed to be installed.
 - 2. Prove that the sensor is suitable for the proposed application and that 100% coverage has been provided.

1.6 QUALITY ASSURANCE

1.7 Manufacturer: Minimum 10 years experience in manufacture of lighting controls.

1.8 PROJECT CONDITIONS

- A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - 1. Ambient temperature: 0° to 40° C (32° to 104° F).
 - 2. Relative humidity: Maximum 90 percent, non-condensing.

1.9 WARRANTY

- A. Provide a five year warranty on all room control devices and panels.

1.10 MAINTENANCE

- A. Spare Parts:
 - 1. Provide the minimum of 5% or [5] of each of the following spares of each product that are used on this project to be used for maintenance as listed below:
 - a. Single-zone room controller
 - b. Two-zone room controller
 - c. Three-zone room controller
 - d. Single-zone dimming controller
 - e. Two-zone dimming controller
 - f. Three-zone dimming controller
 - g. Plug load controller
 - h. Fixture controller
 - i. Network bridge
 - j. Isolated auxiliary relay
 - k. Ceiling occupancy sensor (each type used)
 - l. Wall mount occupancy sensor (each type used)
 - m. Wall switch (each type used)
 - n. Interior photocell

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer:
 - 1. Basis of design product: WattStopper Digital Lighting Management (DLM)
 - 2. Subject to compliance and prior approval with specified requirements of this section, one of the following:
 - a. Refer to drawings for approved manufacturers
 - 3. Substitutions: All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the bid date and must be made available to all bidders.

Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.

2.2 DIGITAL LIGHTING CONTROLS

- A. Furnish the Company's system which accommodates the square-footage coverage requirements for each area controlled with 100% coverage, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories which suit the lighting and electrical system parameters.

2.3 LOCAL NETWORK (Room Network)

- A. The local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building.
- B. Features of the local network include:
 - 1. Automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
 - 2. Simple replacement of any device in the local network with a standard off the shelf unit without requiring significant commissioning, configuration or setup.
 - 3. Push and learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
 - 4. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.
- C. Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices.
- D. If manufacturer's pre-terminated Cat5e cables are not used for the installation, the contractor is responsible for testing each cable following installation and supplying manufacturer with test results.

2.4 DIGITAL LOAD CONTROLLERS (ROOM, PLUG LOAD AND FIXTURE CONTROLLERS)

- A. Digital controllers for lighting and plug loads automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room and plug load controllers shall be provided to match the room lighting and plug load control requirements. The controllers will be simple to install, and will not have dip switches or potentiometers, or require special configuration for standard automatic configuration applications. The control units will include the following features:
 - 1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
 - 2. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf.
 - 3. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are sequentially assigned using each controller's device ID's from highest to lowest.
 - 4. Device Status LEDs to indicate:
 - a. Data transmission

- b. Device has power
 - c. Status for each load
 - d. Configuration status
 5. Quick installation features including:
 - a. Standard junction box mounting
 - b. Quick low voltage connections using standard RJ-45 patch cable
 6. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
 - a. Turn on to 100%
 - b. Turn off
 - c. Turn on to last level
 7. Each load shall at a minimum be configurable to operate in the following sequences based on occupancy:
 - a. Auto-on/Auto-off (Follow on and off)
 - b. Manual-on/Auto-off (Follow off only)
 8. The polarity of each load output shall be reversible, via digital configuration, so that on is off and off is on.
 9. BACnet object information shall be available for the following objects:
 - a. Load status
 - b. Electrical current (when available)
 - c. Total watts per controller
 - d. Schedule state – normal or after-hours
 - e. Demand response enable and disable
 - f. Room occupancy status
 - g. Total room lighting and plug loads watts
 - h. Total room watts/sq ft
 - i. Force on/off all loads
 10. UL 2043 plenum rated
 11. Manual override and LED indication for each load
 12. Dual voltage (120/277 VAC, 60 Hz), or 347 VAC, 60 Hz (selected models only). 120/277 volt models rated for 20A total load, derating to 16A required for some dimmed loads (forward phase dimming); 347 volt models rated for 15A total load; plug load controllers carry application-specific UL 20 rating for receptacle control.
 13. Zero cross circuitry for each load
 14. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
- B. On/Off Room Controllers shall include:
1. One or two relay configuration
 2. Efficient 150 mA switching power supply
 3. Three RJ-45 local network ports with integral strain relief and dust cover
- C. On/Off/Dimming enhanced Room Controllers shall include:
1. Real time current monitoring
 2. Multiple relay configurations
 - a. One, two or three relays
 - b. One or two relays
 3. Efficient 250 mA switching power supply

4. Four RJ-45 local network ports with integral strain relief and dust cover
5. One dimming output per relay
 - a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting.
 - b. Line Voltage, Forward Phase Dimming - Where indicated, one forward phase control line voltage dimming output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads.
 - c. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver.
 - d. The LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
 - e. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100% dimming range defined by the minimum and maximum calibration trim.
 - f. Calibration and trim levels must be set per output channel.
 - g. Devices that set calibration or trim levels per controller are not acceptable.
 - h. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.
6. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
7. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
8. The following dimming attributes may be changed or selected using a wireless configuration tool:
 - a. Establish preset level for each load from 0-100%
 - b. Set high and low trim for each load
 - c. Set lamp burn in time for each load up to 100 hours
9. Override button for each load provides the following functions:
 - a. Press and release for on/off control
 - b. Press and hold for dimming control

D. Plug Load Controllers shall include:

1. One relay configuration with additional connection for unswitched load
2. Configurable additive time delay to extend plug load time delay beyond occupancy sensor time delay (e.g. a 10 minute additive delay in a space with a 20 minute occupancy sensor delay ensures that plug loads turn off 30 minutes after the space is vacated).
3. Factory default operation is Auto-on/Auto-off, based on occupancy
4. Efficient switching power supply
 - a. 150mA
 - b. 250mA

5. RJ-45 local network ports
 - a. Three RJ-45 ports for one relay controller
- E. Fixture Controllers shall include:
 1. A form factor and product ratings to allow various OEM fixture manufacturers to mount the device inside the ballast/driver cavity of standard-sized fluorescent or LED general lighting fixtures.
 2. One 3A 120/277V rated mechanically held relay.
 3. Programmable behavior on power up following the loss of normal power:
 - a. Turn on to 100%
 - b. Turn off
 - c. Turn on to last level
 4. Requirement for 7 mA of 24VDC operating power from the local network.
 - a. The Fixture Controller does not require a connection to a neutral conductor to operate, and unlike other types of Load Controllers it does not contribute power to the local network to drive accessory devices.
 - b. Power to drive the Fixture Controller electronics can come from any Room or Plug Load Controller, Power Booster and/or Zone Controller.
 5. 0-10V dimming capability via a single 0-10 volt analog output from the device for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Fixture Controller.
 6. Terminals to connect an RJ-45 adaptor with 24" leads, mountable in a ½" KO, for connection to the local network.
 - a. The adaptor leads are insulated for use in a fixture cavity, and the lead length allows the OEM fixture manufacturer flexibility to position the Fixture Controller and the RJ45 jack in the best locations on each fixture.
 7. A complete set of dimming features described above in the section detailing On/Off/Dimming Enhanced Room Controllers (subsection C.5 onward).

2.5 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR

- A. Provide complete sensor coverage of all spaces shown with occupancy sensed lighting controls. Location and quantity of devices shall be provided as recommended by manufacturer for complete coverage of room/space.
- B. Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor.
- C. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
 1. Digital calibration and pushbutton configuration for the following variables:
 - a. Sensitivity – 0-100% in 10% increments
 - b. Time delay – 1-30 minutes in 1 minute increments
 - c. Test mode – Five second time delay
 - d. Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - e. Walk-through mode
 2. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the local network.
 3. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.

- b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
 - d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - e. Ultrasonic and Passive Infrared
 - f. Ultrasonic or Passive Infrared
 - g. Ultrasonic only
 - h. Passive Infrared only
 - i. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 4. Two RJ-45 port(s) for connection to local network.
 5. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
 6. Device Status LEDs, which may be disabled for selected applications, including:
 - a. PIR detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding
 7. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
 8. Manual override of controlled loads.
 9. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
- D. BACnet object information shall be available for the following objects:
1. Detection state
 2. Occupancy sensor time delay
 3. Occupancy sensor sensitivity, PIR and Ultrasonic
- E. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology local network. No additional configuration will be required.

2.6 DIGITAL WALL SWITCH OCCUPANCY SENSORS

- A. Provide complete sensor coverage of all spaces shown with occupancy sensed lighting controls. Location and quantity of devices shall be provided as recommended by manufacturer for complete coverage of room/space.
- B. Wallbox mounted passive infrared PIR or dual technology (passive infrared and ultrasonic) digital occupancy sensor with 1 or 2 switch buttons.
- C. Digital Occupancy Sensors shall provide scrolling LCD display for digital calibration and electronic documentation. Features include the following:
 1. Digital calibration and pushbutton configuration for the following variables:
 - a. Sensitivity – 0-100% in 10% increments

- b. Time delay – 1-30 minutes in 1 minute increments
 - c. Test mode – Five second time delay
 - d. Detection technology – PIR, Dual Technology activation and/or re-activation.
 - e. Walk-through mode
 - f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the local network.
2. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.
 - b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically during the configurable period of time (default 10 seconds) after turning off.
 - d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - i Ultrasonic and Passive Infrared
 - ii Ultrasonic or Passive Infrared
 - iii Ultrasonic only
 - iv Passive Infrared only
 3. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 4. Two RJ-45 ports for connection to local network.
 5. Two-way infrared (IR) transceiver to allow remote programming through handheld configuration tool and control by remote personal controls.
 6. Device Status LEDs including
 - a. PIR detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding
 7. Assignment of any occupancy sensor to a specific load within the room without wiring or special tools.
 8. Assignment of local buttons to specific loads within the room without wiring or special tools
 9. Manual override of controlled loads
 10. All digital parameter data programmed into an individual wall switch sensor shall be retained in non-volatile FLASH memory within the wall switch sensor itself. Memory shall have an expected life of no less than 10 years.
- D. BACnet object information shall be available for the following objects:
1. Detection state
 2. Occupancy sensor time delay
 3. Occupancy sensor sensitivity, PIR and Ultrasonic
 4. Button state
 5. Switch lock control
 6. Switch lock status

- E. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology local network. No additional configuration will be required.
- F. Two-button wall switch occupancy sensors, when connected to a single relay dimming room or fixture controller, shall operate in the following sequence as a factory default:
 - 1. Left button
 - a. Press and release - Turn load on
 - b. Press and hold - Raise dimming load
 - 2. Right button
 - a. Press and release - Turn load off
 - b. Press and hold - Lower dimming load
- G. Low voltage momentary pushbuttons shall include the following features:
 - 1. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 - 2. The following button attributes may be changed or selected using a wireless configuration tool:
 - a. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
 - b. Individual button function may be configured to Toggle, On only or Off only.
 - c. Individual scenes may be locked to prevent unauthorized change.
 - d. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 - e. Ramp rate may be adjusted for each dimmer switch.
 - f. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.

2.7 DIGITAL WALL SWITCHES

- A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:
 - 1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
 - 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 - 3. Configuration LED on each switch that blinks to indicate data transmission.
 - 4. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 - d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
 - 5. Programmable control functionality including:

- a. Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority
 - b. Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.
6. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.
- B. BACnet object information shall be available for the following objects:
1. Button state
 2. Switch lock control
 3. Switch lock status
- C. Two RJ-45 ports for connection to local network.
- D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology local network. No additional configuration shall be required to achieve multi-way switching.
- E. The following switch attributes may be changed or selected using a wireless configuration tool:
- F. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
1. Individual button function may be configured to Toggle, On only or Off only.
 2. Individual scenes may be locked to prevent unauthorized change.
 3. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 4. Ramp rate may be adjusted for each dimmer switch.
 5. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependant; each button may be bound to multiple loads.

2.8 HANDHELD USER INTERFACE REMOTES

- A. Battery-operated handheld devices in 1, 2 and 5 button configurations for remote switching or dimming control. Remote controls shall include the following features:
1. Two-way infrared (IR) transceiver for line of sight communication with local network within up to 30 feet.
 2. LED on each button confirms button press.
 3. Load buttons may be bound to any load on a load controller or relay panel and are not load type dependant; each button may be bound to multiple loads.
 4. Inactivity timeout to save battery life.
- B. A wall mount holster and mounting hardware shall be included with each remote control

2.9 DIGITAL DAYLIGHTING SENSORS

- A. Digital daylighting sensors shall work with load controllers and relay panels to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.
1. Closed loop sensors measure the ambient light in the space and control a single lighting zone.
 2. Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.
 3. Dual loop sensors measure both ambient and incoming daylight in the space to insure that proper light levels are maintained as changes to reflective materials are made in a single zone.
- B. Digital daylighting sensors shall include the following features:
1. The sensor's internal photodiode shall only measure lightwaves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.
 2. Sensor light level range shall be from 1-6,553 footcandles (fc).
 3. The capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
 4. For switching daylight harvesting, the photosensor shall provide a field-selectable deadband, or a separation, between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling excessively after they turn off.
 5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
 6. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
 7. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
 8. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
 9. Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
 10. Configuration LED status light on device that blinks to indicate data transmission.
 11. Status LED indicates test mode, override mode and load binding.
 12. Recessed switch on device to turn controlled load(s) ON and OFF.
 13. BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:
 - a. Light level
 - b. Day and night setpoints
 - c. Off time delay
 - d. On and off setpoints

- e. Up to three zone setpoints
 - f. Operating mode – on/off, bi-level, tri-level or dimming
14. One RJ-45 port for connection to local network.
 15. A choice of accessories to accommodate multiple mounting methods and building materials. The photosensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62" thickness. Extended tube photosensors accommodate mounting materials from 0.62"-1.25" thickness. Mounting brackets are compatible with J boxes and wall mounting. Photosensor to be mounted on included bracket below skylight well.
 16. Any load or group of loads in the room can be assigned to a daylighting zone
 17. Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).
 18. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.
- C. Closed loop digital photosensors shall include the following additional features:
1. An internal photodiode that measures light in a 100-degree angle, cutting off the unwanted light from bright sources outside of this cone.
 2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.
 3. Automatically establishes application-specific setpoints following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of loads.
- D. Open loop digital photosensors shall include the following additional features:
1. An internal photodiode that measures light in a 60-degree angle (cutting off the unwanted light from the interior of the room).
 2. Automatically establishes application-specific setpoints following manual calibration using a wireless configuration tool or a PC with appropriate software. For switching operation, an adequate deadband between the ON and OFF setpoints for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.
 3. Each of the three discrete daylight zones can include any non overlapping group of loads in the room.
- E. Dual loop digital photosensors shall include the following additional features:
1. Close loop portion of dual loop device must have an internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from sources outside of this cone
 2. Open loop portion of dual loop device must have an internal photodiode that can measure light in a 60 degree angle, cutting off the unwanted light from the interior of the room.
 3. Automatically establishes application-specific set-points following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of load.

4. Device must reference closed loop photosensor information as a base line reference. The device must be able to analyze the open loop photosensor information to determine if an adjustment in light levels is required.
5. Device must be able to automatically commission setpoints each night to provide adjustments to electrical lighting based on changes in overall lighting in the space due to changes in reflectance within the space or changes to daylight contribution based on seasonal changes.
6. Device must include extendable mounting arm to properly position sensor within a skylight well.

2.10 DIGITAL PARTITION CONTROLS

- A. Partition controls shall enable manual or automatic coordination of lighting controls in flexible spaces with up to four moveable walls by reconfiguring the connected digital switches and occupancy sensors.
- B. Four-button low voltage pushbutton switch for manual control.
 1. Two-way infrared (IR) transceiver for use with configuration remote control.
 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 3. Configuration LED on each switch that blinks to indicate data transmission.
 4. Each button represents one wall; Green button LED indicates status.
 5. Two RJ-45 ports for connection to local network.
- C. Contact closure interface for automatic control via input from limit switches on movable walls.
 1. Operates on Class 2 power supplied by local network.
 2. Includes 24VDC output and four input terminals for maintained third party contact closure inputs.
 3. Input max. sink/source current: 1-5mA
 - a. Logic input signal voltage High: >18VDC
 - b. Logic input signal voltage Low: <2VDC
 4. Four status LEDs under hinged cover indicate if walls are open or closed; support as remote status indicator.
 5. Two RJ-45 ports for connection to local network.

2.11 HANDHELD AND COMPUTER CONFIGURATION TOOLS

- A. A wireless configuration tool facilitates optional customization of local networks using two-way infrared communications, while PC software connects to each local network via a USB interface.
- B. Features and functionality of the wireless configuration tool shall include but not be limited to:
 1. Two-way infrared (IR) communication with IR-enabled devices within a range of approximately 30 feet.
 2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
 3. Must be able to read and modify parameters for load controllers and relay panels, occupancy sensors, wall switches, daylighting sensors, network bridges, and identify devices by type and serial number.

4. Save up to eight occupancy sensor setting profiles, and apply profiles to selected sensors.
5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
6. Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.
7. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
8. Verify status of building level network devices.

2.12 SEGMENT NETWORK (Room to Room Network)

- A. The segment network shall be a linear topology, BACnet-based MS/TP subnet to connect local networks (rooms) and relay panels for centralized control.
 1. Each connected local network shall include a single network bridge, and the network bridge is the only room-based device that is connected to the segment network.
 2. Network bridges, relay panels and segment managers shall include terminal blocks, with provisions for separate "in" and "out" terminations, for segment network connections.
 3. The segment network shall utilize 1.5 twisted pair, shielded, cable or cabling as recommended by manufacturer as supplied by the lighting control manufacturer. The maximum cable run for each segment shall be no less than 4,000 feet. Conductor-to-conductor capacitance of the twisted pair shall be less than 30 pf/ft and have a characteristic impedance of 120 Ohms.
 4. Network signal integrity requires that each conductor and ground wire be correctly terminated at every connected device.
 5. Substitution of manufacturer-supplied cable must be pre-approved: Manufacturer will not certify network reliability, and reserves the right to void warranty, if non-approved cable is installed, and if terminations are not completed according to manufacturer's specific requirements.
 6. Segment networks shall be capable of connecting to BACnet-compliant BAS either directly, via MS/TP, or through NB-ROUTERS, via BACnet/IP or BACnet/Ethernet.

2.13 NETWORK BRIDGE

- A. The network bridge module connects a local network to a BACnet-compliant segment network for communication between rooms, relay panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. The network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver.
 1. The network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
 2. Provide operation to automatically discover room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.
 3. The network bridge shall automatically create standard BACnet objects for selected devices to allow any BACnet-compliant BAS to include lighting

control and power monitoring features as provided by the devices on each local network. BACnet objects will be created for the addition or replacement of any given device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID and physical MS/TP termination per room are not acceptable. Standard BACnet objects shall be provided as follows:

- a. Read/write the normal or after hours schedule state for the room
- b. Read the detection state of each occupancy sensor
- c. Read the aggregate occupancy state of the room
- d. Read/write the On/Off state of loads
- e. Read/write the dimmed light level of loads
- f. Read the button states of switches
- g. Read total current in amps, and total power in watts through the load controller
- h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
- i. Activate a preset scene for the room
- j. Read/write daylight sensor fade time and day and night setpoints
- k. Read the current light level, in footcandles, from interior and exterior photosensors and photocells
- l. Set daylight sensor operating mode
- m. Read/write wall switch lock status
- n. Read watts per square foot for the entire controlled room
- o. Write maximum light level per load for demand response mode
- p. Read/write activation of demand response mode for the room
- q. Activate/restore demand response mode for the room

2.14 LIGHTING CONTROL PANELS AND ZONE CONTROLLER

A. HARDWARE:

Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:

1. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 - 8 relays, 1 - 24 relays and 6 four-pole contactors, or 1 - 48 relays and 6 four-pole contactors.
2. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. Panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features:
 - a. Removable, plug-in terminal blocks with connections for all low voltage terminations.
 - b. Individual terminal block, override pushbutton, and LED status light for each relay.

- c. Direct wired switch inputs associated with each relay shall support 2-wire momentary switches only.
 - d. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches; digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs; digital IO modules capable of receiving momentary or maintained contact closure inputs or analog sensor inputs; digital daylighting sensors; and digital occupancy sensors. Inputs are divided into two separate digital networks, each capable of supplying 250mA to connected devices.
 - e. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.
 - f. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.
 - g. Group and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any set of relays can be associated with a group for direct on/off control or pattern (scene) control via a simple programming sequence using the relay override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99.
 - h. Relay group status for shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.
4. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
- a. Electrical:
 - i 30 amp ballast at 277V
 - ii 20 amp ballast at 347V
 - iii 20amp tungsten at 120V
 - iv 30 amp resistive at 347V
 - v 1.5 HP motor at 120V
 - vi 14,000 amp short circuit current rating (SCCR) at 347V
 - vii Relays shall be specifically UL 20 listed for control of plug-loads
 - b. Mechanical:
 - i Replaceable, ½" KO mounting with removable Class 2 wire harness.
 - ii Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
 - iii Dual line and load terminals each support two #14 - #12 solid or stranded conductors.
 - iv Tested to 300,000 mechanical on/off cycles.
5. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
6. Power supply shall be a multi-voltage (120/277V) transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.
7. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic by

pass of relays controlling emergency circuits upon loss of normal power.

Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700.

8. Integral system clock shall provide scheduling capabilities for panel-only projects without segment networks or BAS control.
 - a. Each panel shall include digital clock capability able to issue system wide automation commands to up to (11) eleven other panels for a total of (12) twelve networked lighting control panels. The clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.
 - b. The clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes.
 - c. The clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for the clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.
 - d. The clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
 - i Scheduled ON / OFF
 - ii Manual ON / Scheduled OFF
 - iii Astro ON / OFF (or Photo ON / OFF)
 - iv Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)
 - e. The user interface shall be a portable IR handheld remote control capable of programming any panel in the system (LMCT-100)
 - f. The clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.
 - g. Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.
9. The lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a Segment Manager controller, via a segment network connection.
10. The lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 MS/TP-based using the BACnet® protocol.
 - a. The panel shall have provision for an individual BACnet device ID and shall support the full 222 range (0 – 4,193,304). The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.

- b. The panel shall support MS/TP MAC addresses in the range of 0 – 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.
 - c. Lighting control relays shall be controllable as binary output objects in the instance range of 1 – 64. The state of each relay shall be readable and writable by the BAS via the object present value property.
 - d. Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 – 64.
 - e. The 99 group Normal Hours/After Hours control objects associated with the panel shall be represented by binary value objects in the instance range of 201 – 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.
 - f. Setup and commissioning of the panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:
 - i Binary output objects in the instance range of 1 – 64 (one per relay) for on/off control of relays.
 - ii Binary value objects in the instance range of 1 – 99 (one per channel) for normal hours/after hours schedule control.
 - iii Binary input objects in the instance range of 1 – 64 (one per relay) for reading true on/off state of the relays.
 - iv Analog value objects in the instance range of 101 – 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace-time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.
 - g. The description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
 - h. The BO and BV 1 – 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (<http://www.bacnet.org/Addenda/Add-135-2010aa.pdf>)
 - i. Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.
 - j. Lockout of all digital switch buttons connected to a given panel shall be command-able via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.
11. In addition to the Relay Panels, a Zone Controller panel shall be available for zero-relay applications. The panel is designed for applications where Fixture Controllers or other distributed load controllers are used to switch and/or dim

the controlled loads. Key similarities of the zone controller panel to and differences from the relay panel design shall include:

- a. It shall use the same intelligence board as the relay panel.
 - b. Shall not include relay driver boards or relays.
 - c. Shall have a removable interior section to facilitate installation, and a Tub/Cover. Cover is for surface mounting applications only.
 - d. Tub shall have two interior KOs to allow installation of Power Boosters. Each installed Power Booster can provide an additional 150 mA for either of the two available local networks provided by the panel.
 - e. All programming and networking (whether Local Network and/or Segment Network) capabilities in the Zone Controller shall be similar to capabilities for relay panels, except for functions designed for panel-mounted HDR relays.
12. To aid in project start up, if Fixture Controllers are connected to an Zone Controller, automatic configuration will establish a unique sequence of operation so that all controlled fixtures will turn on to 50% output when any digital occupancy sensor detects motion.

B. USER INTERFACE

Each lighting control panel system shall be supplied with at least (1) handheld configuration tool. As a remote programming interface the configuration tool shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. The user interface shall have the following panel-specific functions as a minimum:

1. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
2. Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.
3. Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.
4. Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.
5. Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.
6. Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.

2.15 SEGMENT MANAGER

- A. For networked applications, the Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable

of serving up a graphical user interface via a standard web browser utilizing either unencrypted TCP/IP traffic via a configurable port (default is 80) or 256 bit AES encrypted SSL TCP/IP traffic via a configurable port (default is 443).

- B. Each segment manager shall have integral support for at least three segment networks. Segment networks may alternately be connected to the segment manger via external BACnet-to-IP interface routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment network. Provide the quantity of routers and switches as shown on the plans.
- C. Operational features of the Segment Manager shall include the following:
1. Connection to PC or LAN via standard Ethernet TCP/IP via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.
 2. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser. The Segment Manager shall not require installation of any lighting control software on an end-user PC.
 3. Log in security capable of restricting some users to view-only or other limited operations.
 4. Segment Manager shall provide two main sets of interface screens – those used to initially configure the unit (referred to as the config screens), and a those used to allow users to dynamic monitor the performance of their system, and provide a centralized scheduling interface.

Capabilities using the Config Screens shall include:

- a. Automatic discovery of devices and relay panels on the segment network(s). Commissioning beyond activation of the discovery function shall not be required to provide communication, monitoring or control of all local networks and lighting control panels.
- b. Allow information for all discovered devices to be imported into the Segment Manager via a single XML based site file from the Software, significantly reducing the time needed to make a system usable by the end user. Importable information can include text descriptions of every component and individual loads, and automatic creation of room location information and overall structure of network. Info entered should not have to be re-entered manually via keystrokes into the Segment Manager
- c. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.
- d. Ability to view and modify device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-On or Auto-On.
- e. Provide capabilities for integration with a BAS via BACnet protocol. At a minimum, the following points shall be available to the BAS via BACnet IP connection to the segment manager: room occupancy state; room schedule mode; room switch lock control; individual occupancy sensor state; room lighting power; room plug-load power; load ON/OFF state; load dimming level; panel channel schedule state; panel relay state; and Segment

Manager Group schedule state control. Any of above items shall be capable of being moved into an "Export Table" that will provide any integrator with only the data they need, and by using the Export Table effectively create a firewall between the integrator's request for info and the overall system performance.

5. Capabilities using the Segment Manager's Dashboard Screens shall include:
 - a. A dynamic "tile" based interface that allows easy viewing of each individual room's lighting and plug load power consumption, and lighting and plug load power. Tiles will be automatically organized according to location so a single tile for the building summarizes all information for tiles beneath it on every floor, in every area, in every room. Tiles shall be color coded based on three energy target parameters, allowing an owner to quickly identify rooms that are not performing efficiently. Tiles for rooms with occupancy sensors shall include an icon to indicate whether that room is occupied. Tiles shall be clickable, and when clicked the underlying hierarchical level of tiles shall become visible. The tile interface shall be accessible via mouse, or touch screen devices. Tiles shall be created automatically by the segment manager, based on the information found during the device discovery and/or information included in a file imported in from devices (such as tagged descriptions for each room) without any custom programming.
 - b. Ability to set up schedules for local networks (rooms) and panels. Schedules shall be capable of controlling individual rooms with either on/off or normal hours/after hours set controlled zones or areas to either a normal hours or after hours mode of operation. Support for annual schedules, holiday schedules and unique date-bound schedules, as well as astro On or astro Off events with offsets. Schedules shall be viable graphically as time bars in a screen set up to automatically show scheduled events by day, week or month.
 - c. Ability to provide a simple time vs. power graph based on information stored in each Segment Manager's memory (typically two to three days' data).
6. If shown in the contract drawings, Segment Managers shall be integrated into a larger control network by the addition of a Network Supervisor package. The Supervisor is a server level computer running a version of the Segment Manager interface software with dedicated communication and networking capability, able to pull information automatically from each individual Segment Manager in the network. By using a Supervisor, information for individual Segment Managers can be accessed and stored on the Supervisor's hard drive, eliminating the risk of data being overwritten after a few days because of Segment Manager memory limits.
7. The Segment Manager shall allow access and control of the overall system database via Native Niagara AX FOX connectivity. Systems that must utilize a Tridium Niagara controller in addition to the programming, scheduling and configuration server are not acceptable.

D. Segment Manager shall support multiple rooms as follows:

1. Support up to 120 network bridges and 900 digital in-room devices.
2. Support up to 300 network bridges and 2,200 digital in room devices, connected via network routers and switches

3. Segment Manager shall provide capacity for required rooms plus 25% spare capacity for future.

2.16 PROGRAMMING, CONFIGURATION AND DOCUMENTATION SOFTWARE

- A. PC-native application for optional programming of detailed technician-level parameter information for all products, including all parameters not accessible via BACnet and the handled IR configuration tool. Software must be capable of accessing room-level parameter information locally within the room when connected via the optional USB programming adapter, or globally for many segment networks simultaneously utilizing standard BACnet/IP communication.
- B. Additional parameters exposed through this method include but are not limited to:
 1. Occupancy sensor detection LED disable for performance and other aesthetic spaces where blinking LEDs present a distraction.
 2. Six occupancy sensor action behaviors for each controlled load, separately configurable for normal hours and after hours modes. Modes include: No Action, Follow Off Only, Follow On Only, Follow On and Off, Follow On Only with Override Time Delay, Follow Off Only with Blink Warn Grace Time, Follow On and Off with Blink Warn Grace Time.
 3. Separate fade time adjustments per load for both normal and after hours from 0 - 4 hours.
 4. Configurable occupancy sensor re-trigger grace period from 0 - 4 minutes separate for both normal hours and after hours.
 5. Separate normal hours and after hours per-load button mode with modes including: Do nothing, on only, off only, on and off.
 6. Load control polarity reversal so that on events turn loads off and vice versa.
 7. Per-load DR (demand response) shed level in units of percent.
 8. Load output pulse mode in increments of 1 second.
 9. Fade trip point for each load for normal hours and after hours that establishes the dimmer command level at which a switched load closes its relay to allow for staggered On of switched loads in response to a dimmer.
- C. Generation of reports at the whole file, partial file, or room level. Reports include but are not limited to:
 1. Device list report: All devices in a project listed by type.
 2. Load binding report: All load controller bindings showing interaction with sensors, switches, and daylighting.
 3. BACnet points report: Per room Device ID report of the valid BACnet points for a given site's BOM.
 4. Room summary report: Device manifest for each room, aggregated by common BOM, showing basic sequence of operations.
 5. Device parameter report: Per-room lists of all configured parameters accessible via hand held IR programmer for use with O&M documentation.
 6. Scene report: All project scene pattern values not left at defaults (i.e. 1 = all loads 100%, 2 = all loads 75%, 3 = all loads 50%, 4 = all loads 25%, 5-16 = same as scene 1).
 7. Occupancy sensor report: Basic settings including time delay and sensitivity(ies) for all occupancy sensors.
- D. Network-wide programming of parameter data in a spreadsheet-like programming environment including but not limited to the following operations:

1. Set, copy/paste an entire project site of sensor time delays.
 2. Set, copy/paste an entire project site of sensor sensitivity settings.
 3. Search based on room name and text labels.
 4. Filter by product type to allow parameter set by product.
 5. Filter by parameter value to search for product with specific configurations.
- E. Network-wide firmware upgrading remotely via the BACnet/IP network.
1. Mass firmware update of entire rooms.
 2. Mass firmware update of specifically selected rooms or areas.
 3. Mass firmware upgrade of specific products.

2.17 EMERGENCY LIGHTING CONTROL DEVICES

- A. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
1. 120/277 volts, 50/60 Hz, 20 amp ballast rating
 2. Push to test button
 3. Auxiliary contact for remote test or fire alarm system interface

2.18 CONTROL CABLING

- A. Lighting Control Cabling outer jacket color - Black.

PART 3 – EXECUTION

3.1 PRE-INSTALLATION MEETING

- A. A factory authorized manufacturer's representative shall provide the electrical contractor a functional overview of the lighting control system prior to installation. The contractor shall schedule the pre-installation site visit after receipt of approved submittals to review the following:
1. Confirm the location and mounting of all digital devices, with special attention to placement of occupancy and daylighting sensors. Review site conditions and potential conflicts such as furniture.
 2. Review the specifications for low voltage control wiring and termination.
 3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
 4. Discuss requirements for integration with other trades.

3.2 CONTRACTOR INSTALLATION AND SERVICES

- A. Contractor to install all devices and wiring in a professional manner. All line voltage connections to be tagged to indicate circuit and switched legs.
- B. Contractor to install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors. If pre-terminated cable is not used for room/area wiring, the contractor is responsible for testing each field-terminated cable following installation, and shall supply the lighting controls manufacturer with test results. Contractor to install any room to room network devices using manufacturer-

supplied network wire. Network wire substitution is not permitted and may result in loss of product warranty where indicated. Low voltage wiring topology must comply with manufacturer's specifications. Contractor shall route network wiring as shown in submittal drawings as closely as possible, and shall document final wiring location, routing and topology on as built drawings.

- C. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated. Before start up, contractor shall test all devices to ensure proper communication.
- D. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.
 - 1. Adjust time delay so that controlled area remains lighted while occupied.
- E. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
 - 1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - 3. Load Parameters (e.g. blink warning, etc.)
- F. Post start-up tuning – After 30 days from occupancy contractor shall adjust sensor time delays and sensitivities to meet the Owner's requirements. The contractor shall adjust location of sensors and/or provide additional sensors as required to provide proper operation and 100% coverage of occupancy sensed spaces, this shall include all material and labor for a complete and functioning system at no additional cost to the Owner. Provide a detailed report to the Architect / Owner of post start-up activity.

3.3 FACTORY SERVICES

- A. Upon completion of the installation, the manufacturer's factory authorized representative shall start up and verify a complete fully functional system.
- B. The electrical contractor shall provide both the manufacturer and the electrical engineer with three weeks written notice of the system start up and adjustment date.
- C. Upon completion of the system start up, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system
- D. Include a certified lighting control acceptance verified in writing by the factory authorized representative.

3.4 COMMISSIONING SUPPORT SERVICES

- A. On this project, a commissioning agent will be hired to verify the installation and programming of all building systems, which includes the lighting control system. Manufacturer should include an extra day of technician's time to review the functionality and settings of the lighting control hardware with the commissioning agent, including reviewing submittal drawings and ensuring that instructions on how to configure each device are readily available. Manufacturer is NOT responsible for helping the commissioning agent inspect the individual devices. It will be the commissioning agent's responsibility to create and complete any forms required for

the commissioning process, although the manufacturer or contractor may offer spreadsheets and/or printouts to assist the agent with this task.

- B. The commissioning agent shall work with the electrical contractor during installation of the lighting control hardware to become familiar with the specific products. The agent may also accompany the manufacturer's technicians during their start-up work to better understand the process of testing, calibration and configuration of the products. However, the contractor and manufacturer shall ensure that interfacing with the agent does not prevent them from completing the requirements outlined in the contract documents.

3.5 FINE TUNING AFTER SUBSTANTIAL COMPLETION

- A. Provide a factory authorized representative for fine tuning and adjustments to the system within 6 months after substantial completion as coordinated and requested by the Owner. Modify and adjust controls, settings, and programming as directed by Owner.

END OF SECTION 26 0923

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

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: Distribution, dry-type transformers rated 600 V and less, with capacities up to 1500 kVA.

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 and size of transformer.
 - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For transformers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 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.
- B. Source quality-control reports.

- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Eaton.
 2. General Electric Company.
 3. Siemens Power Transmission & Distribution, Inc.
 4. Square D; by Schneider Electric.
- B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- 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.
- C. Transformers Rated 15 kVA and Larger: Comply with NEMA TP 1 energy-efficiency levels as verified by testing according to NEMA TP 2.
- D. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
- E. Coils: Continuous windings without splices except for taps.
 1. Internal Coil Connections: Brazed or pressure type.
 2. Coil Material: Copper only. (Aluminum is not acceptable)
- F. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

- G. Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Cores: One leg per phase.
- D. Enclosure: Ventilated.
 - 1. NEMA 250, Type 2
 - 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
- E. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finish Color: Gray.
- F. Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.
- G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- I. Insulation Class, Smaller than 30 kVA: 185 deg C, UL-component-recognized insulation system with a maximum of 115-deg C rise above 40-deg C ambient temperature.
- J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150-deg C rise above 40-deg C ambient temperature.
- K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 - 2. Indicate value of K-factor on transformer nameplate.
 - 3. Unit shall meet requirements of NEMA TP 1 when tested according to NEMA TP 2 with a K-factor equal to one.
 - 4.
- L. Neutral: Rated 200 percent of full load current for K-factor rated transformers.
- M. Wall Brackets: Manufacturer's standard brackets.

- A. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
 - 1. Resistance measurements of all windings at the rated voltage connections and at all tap connections.
 - 2. Ratio tests at the rated voltage connections and at all tap connections.
 - 3. Phase relation and polarity tests at the rated voltage connections.
 - 4. No load losses, and excitation current and rated voltage at the rated voltage connections.
 - 5. Impedance and load losses at rated current and rated frequency at the rated voltage connections.
 - 6. Applied and induced tensile tests.
 - 7. Regulation and efficiency at rated load and voltage.
 - 8. Insulation Resistance Tests:
 - a. High-voltage to ground.
 - b. Low-voltage to ground.
 - c. High-voltage to low-voltage.
 - 9. Temperature tests.
- B. Factory Sound-Level Tests: Conduct prototype sound-level tests on production-line products.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.
 - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
 - 2. Brace wall-mounted transformers as specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases according to Section 033053 "Miscellaneous Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.

B. Remove and replace units that do not pass tests or inspections and retest as specified above.

C. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262413 - SWITCHBOARDS

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. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

1.3 ACTION SUBMITTALS

- A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.
 1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 2. Detail enclosure types for types other than NEMA 250, Type 1.
 3. Detail bus configuration, current, and voltage ratings.
 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
 6. Detail utility company's metering provisions with indication of approval by utility company.
 7. Include evidence of NRTL listing for series rating of installed devices.
 8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 9. 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.

10. Include diagram and details of proposed mimic bus.
11. Include schematic and wiring diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For switchboards, overcurrent protective devices, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 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.
- B. 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.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," 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 graph paper; include selectable ranges for each type of overcurrent protective device.

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. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
 2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.

4. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1.8 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 heating (250 W per section) to prevent condensation.
- C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.9 FIELD CONDITIONS

- A. Installation Pathway: 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 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 following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 1. Notify Architect no fewer than seven days in advance of proposed interruption of electric service.
 2. Indicate method of providing temporary electric service.
 3. Do not proceed with interruption of electric service without Architect's or Owner's written permission.
 4. Comply with NFPA 70E.

1.10 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.
 - 1. Coordinate layout and installation with other trades such that piping, ducts and other equipment foreign to the electrical installation will not be install over the top of the switchboards.
- 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 with concrete.

1.11 WARRANTY

- A. **Manufacturer's Warranty:** Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. **Seismic Performance:** Switchboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. **Basis for Certification:** Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
 - 2. 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 and the unit will be fully operational after the seismic event."

2.2 SWITCHBOARDS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. General Electric Company.
 - 3. Square D; by Schneider Electric.
- B. **Source Limitations:** Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

- C. Product Selection for Restricted Space: 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: 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.
- H. Front-Connected, Front-Accessible, Dead Front Switchboards:
 - 1. Main Devices: Fixed, individually mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections front and rear aligned.
- I. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
 - 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 and the unit will be fully operational after the seismic event."
- J. Indoor Enclosures: Steel, NEMA 250, Type 2.
- K. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- L. Outdoor Enclosures: Type 3R.
 - 1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
 - 2. Enclosure: Downward, rearward sloping roof; bolt-on rear covers for each section, with provisions for padlocking. Retain one of two subparagraphs below. Retain first subparagraph to require switchboard manufacturer to provide power through a control transformer. Retain second if power from a remote source is indicated on Drawings. Coordinate with Drawings.
 - 3.
- M. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.
- N. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility

company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

- O. Customer Metering Compartment: 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. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.
- P. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- Q. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.
- R. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- S. 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.
- T. Buses and Connections: Three phase, four wire unless otherwise indicated.
 - 1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
 - 2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity
 - 3. Copper feeder circuit-breaker line connections.
 - 4. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 - 5. 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.
 - 6. 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.
 - 7. Disconnect Links:
 - a. Isolate neutral bus from incoming neutral conductors.
 - b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.

8. 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.
 9. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- U. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- V. Bus bracing and short circuit rating shall be fully rated to meet the minimum fault current available at the equipment, and if not indicated shall be minimum 65,000 AIC.

2.3 SURGE PROTECTION DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advanced Protection Technologies Inc. (APT).
 2. Eaton.
 3. General Electric Company.
 4. Square D; by Schneider Electric.
- B. SPDs: Comply with UL 1449, Type 1.
- C. Features and Accessories:
1. Integral disconnect switch.
 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 3. Indicator light display for protection status.
 4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
 5. Surge counter.
- D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 250kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- E. Protection modes and UL 1449 VPR for grounded wye, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.
 2. Line to Ground: 1200 V for 480Y/277 V; 1200 V for 208Y/120 V.
 3. Line to Line: 2000 V for 480Y/277 V; 1000 V for 208Y/120 V.
- F. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:
1. Line to Neutral: 700 V.
 2. Line to Ground: 700 V.
 3. Line to Line: 1000 V.

- G. SCCR: Equal or exceed 100 kA.
- H. Nominal Rating: 20 kA.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long and short time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 - 4. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 5. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e.
 - f. Shunt Trip (where indicated): 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - g.
 - h. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
- B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- C. Fuses are specified in Section 262813 "Fuses."

2.5 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, and the following:

1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, tapped secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; bar or window type; double secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

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: Plus or minus 0.5 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
 - d. Megawatts: Plus or minus 1 percent.
 - e. Megavars: Plus or minus 1 percent.
 - f. Power Factor: Plus or minus 1 percent.
 - g. Frequency: Plus or minus 0.1 percent.
 - h. Total Harmonic Distortion.
 - i. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
 - j. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
 - k. Contact devices to operate remote impulse-totalizing demand meter.
 - l. Ethernet card for connection to central utility management system.
2. Interface for Remote Reading:
 - a. Serial Interface: RS-485, with Modbus RTU protocol.
 - b. TCP/IP adapter.
3. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.6 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
- B.**
- C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

- D. 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.

2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.
- C. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.
- D. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

2.8 IDENTIFICATION

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
 - 1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
 - 2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
 - 3. Protect from moisture, dust, dirt, and debris during storage and installation.
 - 4. Install temporary heating during storage per manufacturer's instructions.
- 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 or that affect the performance of the equipment.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1.
- B. Equipment Mounting: Install switchboards on concrete base, **4-inch (100-mm)** nominal thickness. Comply with requirements for concrete base specified in Section 033053 "Miscellaneous Cast-in-Place Concrete."
 - 1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend **2 inches (50-mm)** above concrete base after switchboard is anchored in place.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of concrete base.
 - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to switchboards.
 - 6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
- D. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- 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, surge protection devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- H. Install spare-fuse cabinet.
- I. Comply with NECA 1.

3.3 CONNECTIONS

- A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.
- B. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.

- C. Support and secure conductors within the switchboard according to NFPA 70.
- D. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections:
 - 1. Acceptance Testing:
 - a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
 - b. Test continuity of each circuit.
 - 2. Test for supply voltage 150% of normal.
 - 3. Test ground-fault protection of equipment for service equipment per NFPA 70.
 - 4. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 5. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 6. **Perform the following infrared scan tests and inspections, and prepare reports for all equipment including: new, existing, & salvaged-reinstalled:**
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front 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.

7. 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.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.

3.7 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.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

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. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Fusible selective coordination branch-circuit panelboards.
 - 4. Elevator shunt-trip fusible distribution panelboards.
 - 5. Surge protection devices.

1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
 - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of NRTL listing for series rating of installed devices.
7. Include evidence of NRTL listing for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

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. Keys: Two spares for each type of panelboard cabinet lock.
 2. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.9 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards 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.

1.10 COORDINATION

- ### A. Coordinate layout and installation of panelboards 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.

1. Coordinate layout and installation with other trades such that piping, ducts and other equipment foreign to the electrical installation will not be install over the top of the panelboards.

- ### 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 with concrete.

1.11 WARRANTY

- ### A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. 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.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.
- F. Enclosures: Flush and Surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Kitchen and wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 2. Height: 84 inches (2.13 m) maximum.
 3. Hinged Front Cover (Door-in-Door construction): Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
 4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 6. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
- G. Incoming Mains:
1. Location: Convertible between top and bottom.
 2. Main Breaker: All panelboards shall have a main breaker.
- H. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
 - c. Bus shall be located in the rear of the cabinet.
 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 4. Isolated Ground Bus (where indicated): Adequate for branch-circuit isolated ground conductors; insulated from box.
 5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
 6. Extra-Capacity Neutral Bus (where indicated): Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads. Connectors shall be sized for double-sized or parallel. Do not mount neutral bus in gutter.
 7. Split Bus: Vertical buses divided into individual vertical sections.

- I. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Terminations shall allow use of 75 deg C rated conductors without derating.
 - 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 - 4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
 - 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
 - 6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 - 8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
 - 9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

- J. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

- K. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

- A. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity. Series ratings are not acceptable.
 - 1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
 - 2. Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.
 - 3. If not shown or otherwise indicated, panelboards shall have a minimum rating of 65,000 AIC.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. 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."

- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1 for Service Entrance, and Type 2 for panelboards downstream of service entrance.

2.3 POWER DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. General Electric Company; GE Energy Management - Electrical Distribution.
 - 3. Square D; by Schneider Electric.
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than **36 inches (914 mm)** high, provide two latches, keyed alike.
- D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices: Fused switches.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. General Electric Company; GE Energy Management - Electrical Distribution.
 - 3. Square D; by Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- D. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.5 FUSIBLE SELECTIVE COORDINATION BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussmann
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. Siemens Energy & Automation, Inc.

- B. Panelboard branch circuits shall incorporate overcurrent protection and branch-circuit rated disconnecting means into a single integrated component.
 - C. Panelboard shall be equipped with a six-space spare fuse holder for storing replacement branch circuit fuses. Spare fuse holder shall be located behind locking panel door.
 - D. Panelboard overcurrent protective device interrupting ratings shall be fully rated for the maximum available fault current and have a UL Listed interrupting rating of 300kA and CSA Certified interrupting rating of 200kA.
 - E. Main Disconnect: Quick-make, quick break type.
 - 1. Permanently installed lockout means shall be provided on the main disconnect for lockout tag-out procedures.
 - 2. Ratings up to 400A.
 - F. Branch Fused Disconnects:
 - 1. Branch circuit switches shall have visible circuit ON/OFF indication with colored and international symbol markings.
 - 2. Branch circuit switches open fuse indication via permanently installed neon indicating light.
 - 3. Device shall be UL and cUL Listed 600Vac, 200kA short-circuit current rating, load-break disconnect with amperage ratings and number of poles as indicated on the panelboard schedule.
 - 4. Fuse and disconnect assembly shall be a finger-safe component with trim installed.
 - 5. Fuse and disconnect shall be mechanically interlocked so as not to allow fuse removal while fuse terminals are energized.
 - 6. Branch circuit switches shall have bolt-on style bus connectors.
 - 7. Branch circuit switches housing shall be clearly marked with device amperage.
 - 8. Permanently installed lockout means shall be provided on the device for lockout tag-out procedures. Permanently installed means for locking device in the ON position shall also be provided where indicated on associated schedules or drawings.
 - 9. Branch circuit switches shall provide fuse ampere rating rejection at the following ampacities to ensure continued circuit protection at the specified circuit rating (1-pole, 2-pole and 3-pole types): 15A, 20A, 30A, 40A, 50A, 60A, 70A, 80A & 100A.
 - G. Enclosures: Boxes shall be a nominal 20 inches wide and 5-³/₄ inches deep with wire bending space per the National Electrical Code.
 - H. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
 - I. Covers: Hinged front cover (door-in-door) type.
- 2.6 ELEVATOR SHUNT-TRIP FUSIBLE DISTRIBUTION PANELBOARDS
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussmann
 - B. Ratings: Panelboard assemblies, control wiring and accessories shall have a short-circuit current rating of 200,000A rms symmetrical at the voltage indicated on the drawings.

- C. Selective coordination: Feeders for multiple elevator installations shall be selective coordinated in accordance with NEC 620.62.
- D. Construction:
1. Box shall be Type 1 galvanized steel with interior mounting studs as standard.
 2. Interiors shall be factory assembled.
 3. Main bus shall be plated copper sized in accordance with UL 67 heat-rise tests.
 4. Fully rated solid neutral bus shall be provided for panelboards with neutral.
 5. Solidly bonded copper equipment ground bar shall be provided.
- E. Main Device: Provide main lugs only or main fused device (with or without shunt-trip and control wiring) as shown on the drawings.
- F. Main/Feeder/Branch Devices:
1. Provide shunt-trip fused distribution panel with fused disconnect switches (with or without shunt-trip as indicated) and an accessory control enclosure with all necessary relay(s), control transformer and other options for each shunt-trip fused disconnect switch, as shown on drawings and listed below:
 - a. Shunt-trip fused disconnect switch:
 - 1) Ampere rating of the switch shall be based upon the elevator manufacturer requirements.
 - 2) Short-circuit current rating of 200,000A.
 - 3) Interlocks to prevent the opening of the cover when the switch is in the ON position. Interlock shall be defeatable for testing purposes.
 - 4) Handle lockable in OFF position.
 - b. Accessory Control Enclosure (contains accessories for each shunt-trip fused disconnect switch):
 - 1) 100VA/120V control power transformer with primary and secondary fuses.
 - 2) Isolation relay (3PDT, 10amp, 120V). The coil of the isolation relay shall be _____ (120V AC or 24V DC). A normally open dry contact shall be provided by the Fire Alarm Safety System to energize the isolation relay and activate the shunt trip solenoid (140VA inrush at 120V). (Note: if 24V DC coil is selected, a separate 24V DC source and contact must be provided by the Fire Alarm Safety System.)
 - 3) Provide additional options as indicated below:
 - a) Key to Test Switch
 - b) "On" Pilot Light (Green, Red or White)
 - c) Isolated Full Capacity Neutral Lug
 - d) 1P NC Mechanical Interlock (required for hydraulic elevators with automatic recall).
 - e) Fire Alarm Voltage Monitoring Relay (Comply with NFPA 72).
 - c. Fused disconnect switch (without shunt trip and control wiring):
 - 1) Short-circuit current rating of 200,000A with Cooper Bussmann LPJ fuses.
 - 2) Interlocks to prevent the opening of the cover when the switch is in the ON position. Interlock shall be defeatable for testing purposes.
 - 3) Handle lockable in OFF position.

2.7 PANELBOARDS WITH INTEGRAL SURGE PROTECTIVE DEVICES

- A. Comply with the requirements indicated above, plus the following:
- B. SPD.
 - 1. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
 - 2. Protection modes and UL 1449 VPR for grounded wye circuits, three-phase, four-wire shall not exceed the following:
 - a. Line to Neutral: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.
 - b. Line to Ground: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.
 - c. Neutral to Ground: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.
 - d. Line to Line: 2000 V for 480Y/277 V; 1200 V for 208Y/120 V.
 - 3. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
 - a. Line to Neutral: 700 V.
 - b. Line to Ground: 700 V.
 - c. Neutral to Ground: 700 V.
 - d. Line to Line: 1200 V.
 - 4. SCCR: Equal to the SCCR of the panelboard in which installed.
 - 5. Inominal Rating: 20 kA.
 - 6. Fed with circuit breaker in panelboard and factory mounted within the enclosure. Maintain internal capacity and routing of branch circuit wiring.

2.8 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.

- f. Integral test jack for connection to portable test set or laptop computer.
- g. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response.
- 4. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
- 5. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
- 6. Subfeed Circuit Breakers: Vertically mounted.
- 7. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
 - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - h. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
 - i. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
 - j. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - k. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
 - 1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
 - 2. Fused Switch Features and Accessories:
 - a. Standard ampere ratings and number of poles.
 - b. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.
 - c. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

2.9 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.
 - 2. Indicate final building room numbers, if different than plan room numbers.

2.10 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards 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. Comply with NECA 1.
- C. Install panelboards and accessories according to NEMA PB 1.1.
- D. Equipment Mounting:
 - 1. Install floor-mounted panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033053 "Miscellaneous Cast-in-Place Concrete."
 - 2. Attach panelboard to the vertical finished or structural surface behind the panelboard.
 - 3. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- G. Mount top of trim **80 inches (2030 mm)** above finished floor unless otherwise indicated.
- H. Mount panelboard cabinet plumb and rigid without distortion of box.
- I. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- J. Mount surface-mounted panelboards to steel slotted supports **5/8 inch (16 mm)** in depth. Orient steel slotted supports vertically.
- K. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
 - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- M. Install filler plates in unused spaces.
- N. Stub four **1-inch (25 mm)** empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four **1-inch (25 mm)** empty conduits into raised floor space or below slab not on grade.
- O. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- P. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Provide updated printed directories including existing circuiting, reinstalled circuiting, and new circuiting. Contractor to provide as-build documents with circuiting documented to electrical engineer for as-build generation. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

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.
- C. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. 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 panelboard. Remove front panels so joints and connections are accessible to portable scanner.
- b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 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.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. 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, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated

3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 26 2726

WIRING DEVICES

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. Straight-blade convenience, receptacles.
 - 2. USB charger devices.
 - 3. GFCI receptacles.
 - 4. Hazardous (classified) location receptacles.
 - 5. Twist-locking receptacles.
 - 6. Pendant cord-connector devices.
 - 7. Cord and plug sets.
 - 8. Toggle switches.
 - 9. Decorator-style convenience.
 - 10. Digital timer light switches.
 - 11. Wall-box dimmers.
 - 12. Wall plates.
 - 13. Floor service outlets.
 - 14. Poke-through assemblies.
 - 15. Prefabricated multioutlet assemblies.
 - 16. Service poles.
 - 17.

1.3 DEFINITIONS

- A. Abbreviations of Manufacturers' Names:
 - 1. Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.
 - 2. Hubbell: Hubbell Incorporated: Wiring Devices-Kellems.
 - 3. Leviton: Leviton Mfg. Company, Inc.
 - 4. Pass & Seymour: Pass& Seymour/Legrand.
- B. BAS: Building automation system.
- C. EMI: Electromagnetic interference.
- D. GFCI: Ground-fault circuit interrupter.
- E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.7 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. Poke-Through, Fire-Rated Closure Plugs: One for every ten floor service outlets installed, but no fewer than two.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton (Arrow Hart).
 - 2. Hubbell Incorporated; Wiring Device-Kellems.
 - 3. Leviton Manufacturing Co., Inc.
 - 4. Pass & Seymour/Legrand (Pass & Seymour).
- B. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.
- D. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 - 2. Devices shall comply with the requirements in this Section.
 - 3. Connectors are approved by the university or institution of the project.

- E. Devices for Owner-Furnished Equipment:
 - 1. Receptacles: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.
- F. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STRAIGHT-BLADE RECEPTACLES

- A. Duplex Convenience Receptacles: 125 V, 20 A; back and side wired; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
- B. Hospital-Grade, Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
 - 1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
- C. Isolated-Ground, Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
- D. Tamper-Resistant Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Description: Labeled and complying with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.3 USB CHARGER DEVICES

- A. Tamper-Resistant, USB Charger Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1310, and FS W-C-596.
 - 1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
 - 2. USB Receptacles: Dual, Type A.
 - 3. Line Voltage Receptacles: Dual, two pole, three wire, and self-grounding.

2.4 GFCI RECEPTACLES

- A. General Description:
 - 1. 125 V, 20 A, straight blade, non-feed-through type.
 - 2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
 - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles.
- C. Tamper-Resistant, Duplex GFCI Convenience Receptacles.

- D. Hospital-Grade, Duplex GFCI Convenience Receptacles: Comply with UL 498 Supplement sd.

2.5 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

- A. Hazardous (Classified) Locations Receptacles: Comply with NEMA FB 11 and UL 1010.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. EGS/Appleton Electric.
 - c. Killark.

2.6 TWIST-LOCKING RECEPTACLES

- A. Twist-Lock, Single Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
- B. Twist-Lock, Isolated-Ground, Single Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
1. Grounding: Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.7 PENDANT CORD-CONNECTOR DEVICES

- A. Description:
1. Matching, locking-type plug and receptacle body connector.
 2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
 3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
 4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.8 CORD AND PLUG SETS

- A. Description:
1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
 3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.9 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
 - 1. Single Pole
 - 2. Two Pole
 - 3. Three Way
 - 4. Four Way
- C. Pilot-Light Switches: 120/277 V, 20 A.
 - 1. Description: Single pole, with LED-lighted handle, illuminated when switch is off.
- D. Key-Operated Switches: 120/277 V, 20 A.
 - 1. Description: Single pole, with factory-supplied key in lieu of switch handle.
- E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.
- F. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

2.10 DECORATOR-STYLE DEVICES

- A. Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.
- B. Tamper-Resistant Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.
 - 1. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.
- C. Tamper-Resistant and Weather-Resistant Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.
 - 1. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section, when installed in wet and damp locations.
- D. GFCI, Non-Feed-Through Type, Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.
- E. GFCI, Tamper-Resistant and Weather-Resistant Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.
 - 1. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.
- F. Toggle Switches: Square Face, 120/277 V, 15 A; comply with NEMA WD 1, UL 20, and FS W-S-896.

- G. Lighted Toggle Switches: Square Face, 120 V, 15 A; comply with NEMA WD 1 and UL 20.
 - 1. Description: With LED-lighted handle, illuminated when switch is off.

2.11 DIGITAL TIMER LIGHT SWITCH

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton (Arrow Hart).
 - 2. Hubbell Incorporated; Wiring Device-Kellems.
 - 3. Leviton Manufacturing Co., Inc.
- B. Description: Switchbox-mounted, combination digital timer and conventional switch lighting-control unit, with backlit digital display, with selectable time interval in 10-minute increments.
 - 1. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 A at 277-V ac for fluorescent or LED lighting, and 1/4 hp at 120-V ac.
 - 2. Integral relay for connection to BAS.

2.12 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
- C. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
- D. LED Lamp Dimmer Switches: Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.13 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: Provide device color and full range of finished metal wall plates as selected by the Architect. Refer to architectural sheets for additional information.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.14 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Rectangular, die-cast aluminum with satin finish.
- D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for UTP cable complying with requirements of the voice/data cabling installer.

2.15 POKE-THROUGH ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Incorporated; Wiring Device-Kellems.
 - 2. Thomas & Betts Corporation; A Member of the ABB Group.
 - 3. Wiremold / Legrand.
- B. Description:
 - 1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
 - 2. Comply with UL 514 scrub water exclusion requirements.
 - 3. Service-Outlet Assembly: Flush type with four simplex receptacles and space for four RJ-45 jacks complying with requirements of the voice/data cabling installer.
 - 4. Size: Selected to fit nominal **3-inch (75-mm)** or **4-inch (100-mm)** cored holes in floor and matched to floor thickness.
 - 5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 - 6. Closure Plug: Arranged to close unused cored openings and reestablish fire rating of floor.
 - 7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, four-pair cables that comply with requirements in Section 27 1500 "Communications Horizontal Cabling."

2.16 PREFABRICATED MULTIOUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Incorporated; Wiring Device-Kellems.
 - 2. Wiremold / Legrand.
- B. Description:
 - 1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
 - 2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

- C. Raceway Material: Metal, with manufacturer's standard finish.
- D. Multioutlet Harness:
 - 1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
 - 2. Receptacle Spacing: 12 inches (300 mm).
 - 3. Wiring: No. 12 AWG solid, Type THHN copper, single circuit.

2.17 SERVICE POLES

- A. Description:
 - 1. Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
 - 2. Poles: Nominal 2.5-inch- (65-mm-) square cross section, with height adequate to extend from floor to at least 6 inches (150 mm) above ceiling, and with separate channels for power wiring and voice and data communication cabling.
 - 3. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
 - 4. Finishes: Manufacturer's standard painted finish and trim combination.
 - 5. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, four-pair, Category 3 or Category 5 voice and data communication cables.
 - 6. Power Receptacles: Two duplex, 20-A, straight-blade receptacles complying with requirements in this Section.
 - 7. Voice and Data Communication Outlets: Four RJ-45 jacks complying with requirements of voice/data installer.
 - 8.

2.18 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Red.
 - 3. Isolated-Ground Receptacles: As specified above, with orange triangle on face.
- B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:

1. Protect installed devices and their boxes. 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 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.

C. Conductors:

1. Do not strip insulation from conductors until right 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. Pigtailling existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that 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 (152 mm)** in length.
5. Feed-through wiring from one receptacle to another is not allowed.
6. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
7. Use a torque screwdriver when a torque is recommended or required by manufacturer.
8. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
9. Tighten unused terminal screws on the device.
10. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.

F. 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.

G. Dimmers:

1. Install dimmers within terms of their listing.

2. Verify that dimmers used for fan-speed control are listed for that application.
 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

- A. Comply with Section 26 0553 "Identification for Electrical Systems."
- B. Identify each receptacle, switch and blank cover plate as follows. Use hot, stamped, or engraved machine printing with black-filled lettering on device or plate, and durable wire markers or tags inside outlet boxes. Labels shall be made with a "Dymo Rhino RO 5000 ®", or approved equal.
1. Circuit Numbers: Identify each with panelboard identification and circuit number on device plate.
 2. Switched Receptacles: Identify each with the text "CONTROLLED" on the device.

3.4 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Perform the following tests and inspections:
1. Test Instruments: Use instruments that comply with UL 1436.
 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- D. 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 unacceptable.
 3. Ground Impedance: Values of up to 2 ohms 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. 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.

- E. Wiring device will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 26 2726

SECTION 26 2813

FUSES

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. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Control circuits.
 - b. Motor-control centers.
 - c. Panelboards.
 - d. Switchboards.
 - e. Enclosed controllers.
 - f. Enclosed switches.
 - 2. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in PDF format.
 - 5. Coordination charts and tables and related data.
 - 6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 7700 "Closeout Procedures," include the following:
1. Ambient temperature adjustment information.
 2. Current-limitation curves for fuses with current-limiting characteristics.
 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in PDF format.
 4. Coordination charts and tables and related data.

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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 FIELD CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bussmann, an Eaton business.
 2. Edison; a brand of Bussmann by Eaton.
 3. Littlefuse
 4. Ferraz Shawmut
- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 2. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.

4. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 5. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
- 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.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.3 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
 2. Finish: Gray, baked enamel.
 3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
1. Service Entrance: Class L, time delay.
 2. Feeders: Class J, time delay.
 3. Motor Branch Circuits: Class RK5, time delay.
 4. Large Motor Branch (601-4000 A): Class L, time delay.

5. Other Branch Circuits: Class CC, fast acting.
6. Control Transformer Circuits: Class CC, time delay, control transformer duty.
7. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Architect.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 2813

SECTION 26 2816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Shunt trip fusible switches (elevator disconnects).
 - 4. Molded-case circuit breakers (MCCBs).
 - 5. Molded-case switches.
 - 6. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.
- B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 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.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

1.7 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 2. Fuse Pullers: Two for each size and type.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 1. Ambient Temperature: Not less than **minus 22 deg F (minus 30 deg C)** and not exceeding **104 deg F (40 deg C)**.
 2. Altitude: Not exceeding **6600 feet (2010 m)**.

1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. 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 and the unit will be fully operational after the seismic event."

2.2 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

2.3 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. General Electric Company; GE Energy Management - Electrical Distribution.
 - 3. Siemens Energy.
 - 4. Square D; by Schneider Electric.
- B. Type HD, Heavy Duty:
 - 1. 600-V ac.
 - 2. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
 - 3. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.
8. Service-Rated Switches: Labeled for use as service equipment.

2.4 NONFUSIBLE SWITCHES

- A. Type HD, Heavy Dut, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- B. Accessories:
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
 6. Hookstick Handle: Allows use of a hookstick to operate the handle.
 7. Lugs: Mechanical type, suitable for number, size, and conductor material.
 8. Service-Rated Switches: Labeled for use as service equipment.

2.5 SHUNT TRIP FUSIBLE SWITCHES (ELEVATOR DISCONNECTS)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Bussman
 2. Eaton.
 3. General Electric Company; GE Energy Management - Electrical Distribution.
 4. Siemens Energy.
 5. Square D; by Schneider Electric.
- B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with Class J fuse block and 200-kA interrupting and short-circuit current rating.
- C. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: 600-V ac; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to

accommodate indicated fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, pilot, indicating and control devices.
- E. Accessories:
 - 1. Oiltight key switch for key-to-test function.
 - 2. Oiltight red ON pilot light.
 - 3. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
 - 4. Form C alarm contacts that change state when switch is tripped.
 - 5. Three-pole, double-throw, fire-safety and alarm relay; [120-V ac] [24-V dc] coil voltage.
 - 6. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.
 - 7. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 8. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 - 9. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 10. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
 - 11. Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 12. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 13. Service-Rated Switches: Labeled for use as service equipment.

2.6 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. General Electric Company; GE Energy Management - Electrical Distribution.
 - 3. Siemens Energy.
 - 4. Square D; by Schneider Electric.
- B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.
- D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated or series rated as indicated on the Drawings. Circuit breaker/circuit breaker combinations for series connected interrupting ratings shall be listed by UL as recognized component combinations. Any series rated combination

used shall be marked on the end-use equipment along with the statement "Caution - Series Rated System. _____ Amps Available. Identical Replacement Component Required."

- E. MCCBs shall be equipped with a device for locking in the isolated position.
- F. Lugs shall be suitable for 167 deg F (75 deg C) rated wire.
- G. Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I-squared t response.
- K. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- L. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 7. Accessory Control Power Voltage: Integrally mounted, self-powered.

2.7 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).

- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: The circuit-breaker operating handle shall be directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - 6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

3.4 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Comply with mounting and anchoring requirements specified in Section 26 0548.16 "Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in fusible devices.
- F. Comply with NFPA 70 and NECA 1.

3.5 IDENTIFICATION

- A. Comply with requirements in Section 26 0553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that the unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

- a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
 - i. Verify correct phase barrier installation.
 - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
2. Electrical Tests:
- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."
- C. Tests and Inspections for Molded Case Circuit Breakers:
1. Visual and Mechanical Inspection:
 - a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and clearances.
 - d. Verify that the unit is clean.
 - e. Operate the circuit breaker to ensure smooth operation.
 - f. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

- g. Inspect operating mechanism, contacts, and chutes in unsealed units.
- h. Perform adjustments for final protective device settings in accordance with the coordination study.

2.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

- 1. Test procedures used.
- 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
- 3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

END OF SECTION 26 2816

SECTION 27 3000

TWO WAY COMMUNICATIONS SYSTEM

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. A complete stand-alone two-way communication system with main control station (annunciator), remote call stations, auto-dialer, power supplies, batteries, audio/visual notification devices, controls, relays, and cabling compliant with applicable codes and standards.

1.3 DEFINITIONS

- A. Call Box Station: The Call Box Station must have a bronze or powder coated steel housing, red coil cord emergency handset, be 24vdc or 120vac powered and include a rechargeable battery to maintain backup power for a minimum of 24 hours with 5 minutes of talk time.
- B. Call Box: The Call Boxes must be in full compliance with ADA requirements. Call Boxes require a hands-free speakerphone with an LED to indicate status of call.
- C. BICSI: Building Industry Consulting Service International.
- D. EMI: Electromagnetic interference.
- E. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

1.4 CODE REQUIREMENTS

- A. System shall comply with the current applicable and state approved versions of
 - 1. IBC – International Building Code
 - 2. NFPA 72 – National Fire Alarm and Signaling Code
 - 3. NFPA 101 - Life Safety Code
 - 4. ADA – Americans with Disabilities Act

1.5 SUBMITTALS

- A. General Submittal Requirement:
 - 1. Shop Drawings with dimensions.
 - 2. Equipment cabinet layout drawings

3. Installation instructions.
 4. Product Data: For each type of product indicated.
 5. Detailed wiring diagrams
 6. Voltage drop calculations
 7. Power supply size calculations
 8. Battery sizing calculations
- B. Operation and Maintenance Data: In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Provide "Record of Completion Documents".
 2. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
 3. Manufacturer's required maintenance related to system warranty requirements.
 4. Abbreviated operating instructions for mounting at control unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Rath Communications
 2. Cornell
 3. TALKAPHONE
 4. Prior Approved Equal

2.2 MAIN CONTROL STATION (ANNUNCIATOR)

- A. Description: Call Box Station must have a built-in battery backup and include a rechargeable battery to maintain backup power for a minimum of 24 hours and 5 minutes of talk time. All Call Boxes must be powered from the 24vdc power supply at the Call Box Station location. All wiring will be from the Call Box Station to the Call Box using 2 hour rated cabling.
- B. General Requirements:
1. Flush mounted cabinet, hinged with integral keyed lock.
 2. Provide capacity for number of zones required on drawings plus a minimum of one spare zone. Each call station shall represent a dedicated separate zone.
 3. Control Station shall include both audible (minimum of 90 dB at 30 cm) and visual notification.
 4. Each zone shall be supervised by the control station for faults/shorts and shall alarm (audible/visual) upon fault/short conditions within zone wiring.
 5. Each zone shall include an alternate action switch with internal LED indicator.
 6. Each zone shall include a zone switch that will answer a zone and open the intercom line to the zone for two-way communication.
 7. Includes integral telephone access dialer to place an auto-dial call to owner designated phone number through a dedicated phone line.
 8. Both primary and secondary power supplies shall be monitored for presense of voltage and shall include both an internal and remote trouble alarm upon loss of voltage. Remote

trouble alarm shall include the alarm relay trouble signal for monitoring by the fire alarm system.

- C. Power Supplies (primary power supply):
 - 1. Shall be integral to main call box control station enclosure. Input voltage of 120 VAC, 24VDC output.
 - 2. Shall be sided to supply power to all call box station zones plus 25% spare capacity.
 - 3. Shall be monitored for presence of voltage and shall include both an internal and remote trouble alarm upon loss of voltage. Remote trouble alarm shall include the alarm relay trouble signal for monitoring by the fire alarm system.
 - 4. External an output relay signal.
 - 5. The system must be capable of being programmed with up to 5 emergency numbers.
- D. Battery Backup (secondary power supply):
 - 1. Must be capable of supplying power for 24 Hours with 5 min of talk time at the end of the 24 hours plus 20% spare capacity. Batteries shall be located within the main call box control station enclosure.
- E. Labeling and Instructions:
 - 1. Front panel shall include all required labeling and instructions for use compliant with current code requirements in a permanent silk-screened method.

2.3 REMOTE CALL STATION

- A. Description:
 - 1. Vandal resistant hands free speakerphone for two-way communication with momentary switch and LED indicator light that illuminates upon activation of the station push-button.
 - 2. The Call Station shall be programmed to automatically dial out to pre-programmed emergency numbers if the main control station is not manned 24 hours per day, 7 days per week.
 - 3. The Call Station must have location message capability, and must have a minimum of 18 second recordable message capability, programmable to play 1 or 2 times.
 - 4. Call Station shall notify called party of the location of the call upon being received at the emergency dispatch center.
- B. Labeling and Instructions:
 - 1. Front panel shall include all required labeling and instructions for use compliant with current code requirements in a permanent silk-screened method.

2.4 CABLE

- A. Description: Cabling for the two-way communications system shall meet the applicable code requirements for cable survivability. Cabling must be 2-hour fire-rated circuit integrity (CI) or fire resistive cable or fire-rated cable system.
- B. Manufacturers: Subject to compliance with requirements, provide products equal to the following:
 - 1. Rath Communications - 18/4, 66120
 - 2. Rath Communications - 18/2, RP66010002
 - 3. Rath Communications - 4 pair Cat 5, RP6600100M4
 - 4. Or Prior Approved Equal
- C. Description: 18 AWG 4 Conductor Shielded, 2 Hour Fire Rated.

- 1) NEC type FPL-LS, CM, CL3 & PLTC for use in Electrical Circuit Integrity System FHIT 40A
 - 2) c(UL) listed CM
 - 3) CEC type FAS 90 with Hose Stream Test
 - 4) UL Certified to ANSI/UL 2196 2-Hour fire rating for use in FHIT system 40A. (See UL Fire Resistance Directory R27557)
 - 5) CAN/ULC-S139 Certified with Hose Stream Test for use in FHITC system 40A.
 - 6) UL 1424 Listed FPL-LS for Power-Limited Fire Alarm Cables; 300V / 105°C
 - 7) UL 13 Listed CL3 & PLTC for Power-Limited Circuit Cables; 300V / 105°C
 - 8) UL 444 Listed CM for Communication Cable; 300V / 105°C
 - 9) Fire certified for power-limited system use at 72V phase-to-phase utilization voltage
 - 10) Sunlight resistant
 - 11) For use in wet locations
- D. Description: 18 AWG 2 Conductor Shielded, 2 Hour Fire Rated.
- 12) NEC type FPL-LS, CM, CL3 & PLTC for use in Electrical Circuit Integrity System FHIT 40A
 - 13) c(UL) listed CM
 - 14) CEC type FAS 90 with Hose Stream Test
 - 15) UL Certified to ANSI/UL 2196 2-Hour fire rating for use in FHIT system 40A. (See UL Fire Resistance Directory R27557)
 - 16) CAN/ULC-S139 Certified with Hose Stream Test for use in FHITC system 40A.
 - 17) UL 1424 Listed FPL-LS for Power-Limited Fire Alarm Cables; 300V / 105°C
 - 18) UL 13 Listed CL3 & PLTC for Power-Limited Circuit Cables; 300V / 105°C
 - 19) UL 444 Listed CM for Communication Cable; 300V / 105°C
 - 20) Fire certified for power-limited system use at 72V phase-to-phase utilization voltage
 - 21) Sunlight resistant
 - 22) For use in wet locations

2.5 **GROUNDING**

- A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with ANSI-J-STD-607-A.

2.6 **IDENTIFICATION PRODUCTS**

- A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 **ENTRANCE FACILITIES**

- A. Coordinate analog connection for Two-Way Communications System with owner prior to project completion and inspection.

3.2 **WIRING METHODS**

- A. Wiring Method: Install cables in raceways.

3.3 **FIELD QUALITY CONTROL**

- A. Coordination with Owner:
 - 1. Coordinate with owner for analog line to be ordered from local carrier or provided from owner equipment.
 - 2. Coordinate with owner all numbers to be programmed into Call Box locations.
- B. Tests and Inspections:
 - 1. Visually inspect Call Box Station and Call Boxes and verify all LED indicators function properly.
 - 2. Visually confirm all connections are secured.
 - 3. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
 - a. Voice Tests: These tests assume that dial tone service has been installed. At the Call Box location, push the talk button and confirm calls are routed correctly to the Call Box Station, the outside locations, and emergency dispatch center.
- C. Prepare test and inspection reports.

3.4 **DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel in system management operations, including changing batteries in Call Box and Call Box Station, programming numbers, and system maintenance. rerouting signals in failed cables, and keeping records of cabling assignments and revisions when

END OF SECTION 27 3000

SECTION 27 4100

GENERAL TECHNOLOGY SYSTEMS REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general requirements for Technology systems installations:

1. Summary of work
2. Project Coordination
3. References and Standards
4. Industry Standards
5. Allowances
6. Unit Prices
7. Submittals
8. Substitutions
9. Materials and Equipment
10. Summary Test Report
11. Warranties
12. Permits

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions apply to this section of Division 27.

B. The following general and basic sections of Division 27 pertain to all system specific sections of Division 27. These general and basic information sections shall be complied with by all Technology systems contractors:

1. General Technology Systems Requirements
2. Basic Technology Systems Requirements
3. Basic Technology Systems Materials and Methods

1.3 SUMMARY OF WORK

A. The work consists of, but is not limited to, the construction of integrated audio, video, and control systems. Refer to individual Division 27 sections for additional work summaries and responsibilities.

B. Owner furnished items: The Owner will furnish material and equipment as indicated in the contract documents to be incorporated into the Work. These items are assigned to the installer and costs for receiving, handling, storage, if required, and installation are included in the Contract Sum.

1. The Installer's responsibilities are the same as if the Installer furnished the materials or equipment.
2. The Owner will arrange and pay for delivery of Owner-furnished items FOB job site and the installer will inspect deliveries for damage. If Owner-furnished items are damaged, defective or missing, document damaged items with the transport company and the Owner will arrange for replacement. The Owner will also arrange for manufacturer's field services, and the delivery of manufacturer's warranties and bonds to the Installer.
3. The Installer is responsible for designating the delivery dates of Owner-furnished items and for receiving, unloading and handling Owner-furnished items at the site. The Installer is responsible for protecting Owner-furnished items from damage, including damage from exposure to the elements, and to repair or replace items damaged as a result of his operations.

C. **General:** Comply with requirements of Owner for completion of work. The work will be conducted to provide the least possible interference to the activities of the Owner's personnel and operations.

1.4 PROJECT COORDINATION

A. **General:** Well in advance of installation of every major unit of work which requires coordination and interfacing with other work, meet at project site with installers and representatives of manufacturers and fabricators who are involved in or affected by unit of work and in its coordination and integration with other work which has preceded or will follow. Do not proceed with the work if associated pre-installation conference cannot be concluded successfully. Instigate actions to resolve impediments to performance of the work.

B. **Millwork Contractor:** Coordinate with the Owner's Millwork contractor the wiring configuration, connection requirements, and dimensional layout of the furniture to be provided. Determine whether proposed furniture design will interface with Technology systems design as shown. Notify Architect/Engineer of any discrepancy.

1.5 REFERENCE STANDARDS AND DEFINITIONS

A. **General:** Basic Contract definitions are included in the General Conditions.

B. **Indicated:** The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

C. **Directed:** Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.

D. **Approve:** The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in General and Supplementary Conditions.

E. **Regulation:** The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

F. **Furnish:** The term "furnish" is used to mean "supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations."

G. **Install:** The term "install" is used to describe operations at project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."

H. **Provide:** The term "provide" means "to furnish and install, complete and ready for the intended use."

I. **Installer:** An "Installer" is the Contractor or an entity engaged by the Contractor, either as an employee, subcontractor, or sub-subcontractor, for performance of a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.

J. **Substitutions:** Requests for changes in products, materials, equipment, and methods of construction required by Contract Documents proposed by the Contractor after award of the Contract are considered requests for "substitutions."

1.5 INDUSTRY STANDARDS

A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Where the date of issue of a referenced standard is not specified, comply with the standard in effect as of date of Contract Documents.

C. Conflicting Requirements: Where compliance with two or more standards is specified, and the standards establish different or conflicting requirements for minimum quantities or quality levels, refer requirements that are different, but apparently equal, and uncertainties to the Architect/Engineer for a decision before proceeding.

1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. In complying with these requirements, indicated numeric values are minimum or maximum, as appropriate for the context of the requirements. Refer uncertainties to the Architect/Engineer for a decision before proceeding.

2. Clarification methods: At the time of bidding, bidders shall familiarize themselves with the drawings and specifications. Any questions, misunderstandings, conflicts, deletions, discontinued products, catalog number discrepancies, discrepancies between the equipment supplied and the intent or function of the equipment, etc., shall be submitted to the Architect/Engineer in writing for clarification prior to issuance of the final addendum and bidding of the project. Where discrepancies or multiple interpretations occur, the most stringent (which is generally recognized as the most costly) that meets the intent of the documents shall be enforced.

D. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entity's construction activity. Copies of applicable standards are not bound with the Contract Documents, but can be obtained through the following addresses and telephone numbers:

ANSI American National Standards Institute
11 West 42nd Street, 13th Floor
New York, NY 10036 (212) 642-3300

ASTM American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103 (215) 299-5400

EIA Electronic Industries Assoc.
2001 Pennsylvania Ave., NW, Suite 1100
Washington, DC 20006 (202) 457-4900

ETL ETL Testing Laboratories, Inc.
P.O. Box 2040
Route 11, Industrial Park
Cortland, NY 13045 (607) 753-6711

ICEA Insulated Cable Engineers
Association Inc.
P.O. Box 440
South Yarmouth, MA 02664 (617) 394-4424

IEC International Electrotechnical Commission

(Available from ANSI)

**1430 Broadway
New York, NY 10018 (212) 354-3300**

**IEEE Institute of Electrical and Electronic Engineers
345 E. 47th St.
New York, NY 10017 (212) 705-7900**

NEC National Electric Code (Now NFPA)

**NECA National Electrical Contractors Association
7315 Wisconsin Ave., Suite 1300 W
Bethesda, MD 20814 (301) 657-3110**

**NEMA National Electrical Manufacturers Association
2101 L St., NW, Suite 300
Washington, DC 20037 (202) 457-8400**

**NFPA National Fire Protection Association
One Batterymarch Park
PO Box 9101
Quincy, MA 02269-9101 (617) 770-3000**

**UL Underwriters Laboratories
333 Pfingsten Rd.
Northbrook, IL 60062 (708) 272-8800**

**FS Federal Specification (from GSA)
Specifications Unit (WFSIS)
7th and D St., SW
Washington, DC 20407 (202) 708-9205**

1.6 ALLOWANCES

A. General: Follow the requirements specified in Division 1 Section "ALLOWANCES." Use the contingency allowance only as directed for the Owner's purposes, and only by Change Orders which designate amounts to be charged to the allowance. At Project closeout, credit unused amounts remaining in the contingency allowance to Owner by Change Order.

1.7 UNIT PRICES

A. General: A unit price is an amount proposed by Bidders and stated on the Bid Form as a price per unit of measurement for materials or services that will be added to or deducted from the Contract Sum by Change Order in the event the estimated quantities of Work required by the Contract Documents are increased or decreased. Include all necessary material, overhead, profit and applicable taxes. Comply with unit price requirements identified in individual Division 27 sections.

1.8 SUBMITTALS

A. Submit in accordance with Sections 013310, Submittal Procedures, and 013323, Shop Drawings, Product Data and Samples.

B. General: Follow the procedures specified in Division 27 Sections under "SUBMITTALS." As a minimum, all data shall be submitted in a suitable three ring binder or binders labeled as to project, date, and installer. Include Installers' signature indicating his unqualified approval that the equipment will fit in the space shown, and is complete with all requirements of the plans and specifications. Provide space for "Action" marking. Do not proceed without appropriate "Action" marking. Allow 2

weeks for review.

C. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, as follows, to indicate the action taken:

1. **Final Unrestricted Release:** Where submittals are marked "Reviewed," that part of the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.
2. **Final-But-Restricted Release:** When submittals are marked "Furnished as Corrected," that part of the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.
3. **Returned for Resubmittal:** When submittal is marked "Rejected, Revise and Resubmit," do not proceed with that part of the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the notations; resubmit without delay. Repeat if necessary, to obtain a different action mark.
 - a. Do not permit submittals marked "Not Approved, Revise and Resubmit" to be used at the Project site, or elsewhere where Work is in progress.
4. **Other Action:** Where a submittal is primarily for information or record purposes, special processing or other activity, the submittal will be returned, marked "Action Not Required".

1.9 SUBSTITUTIONS

A. Substitution Request Submittal: Requests for substitution may be considered or rejected at the discretion of the Architect/Engineer.

1. Submit 3 copies of each request for substitution for consideration. Submit requests in the form and in accordance with procedures required for Change Order proposals.
2. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
 - a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
 - b. Samples, where applicable or requested.
 - c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified.
 - d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and other Contractors, that will become necessary to accommodate the proposed substitution.
 - e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
 - f. Cost information, including a proposal of the net change, if any in the Contract Sum.
 - g. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time, that may subsequently become necessary because of the failure of the substitution to perform adequately.
 - h. Certification by the Contractor that the substitution proposed will not require any changes to the planned building infrastructure including, but not limited to conduit, junction boxes, enclosures, rack space, millwork, 120 VAC power, heat dissipation, structural backing, etc.; and will "fit"/work with the infrastructure as originally planned with the specified device.

1.10 MATERIALS AND EQUIPMENT

- A. Source Limitations:** To the fullest extent possible, provide products of the same kind, from a single source where products are part of a single assembly.
- B. Compatibility of Options:** When the Contractor is given the option of selecting between two or more products for use on the Project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.
1. If a dispute arises between Contractors over concurrently selectable, but incompatible products, the Architect/Engineer will determine which products shall be retained and which are incompatible and must be replaced.
- C. Manufacturers:** Select equipment from the manufacturers as identified in the schedules contained in the drawings.

1.11 SUMMARY TEST REPORT

- A. Prepare summary test report in accordance with the requirements in each Division 27 Section. Make all tests required by the authorities having jurisdiction, by the Architect and his consultants, and the Owner. Make tests of the indicated installed conditions, and:**
1. Include tests from final punch list.
2. If there are any abnormal conditions, they shall be brought to the attention of the Engineer in writing as a part of this submittal.

1.12 WARRANTY REQUIREMENTS

- A. Reference Section 01 7800, Closeout Submittals.**
- B. Warranty for a minimum of one year after date of substantial completion all Technology systems equipment and workmanship. When a warranty call is requested by the owner, respond with an on-site service call within 24 hours of the initial call, regardless of if initial contact is made via installing company's personnel or through messaging services.**
- C. Disclaimers and Limitations:** Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.
- D. Reinstatement of Warranty:** When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty.
- E. Related Damages and Losses:** When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- F. Replacement Cost:** Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefitted from use of the Work through a portion of its anticipated useful service life.
- G. Owner's Recourse:** Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.

1. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

H. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

1.13 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.14 PERMITS, FEES

A. Obtain and pay all city, state, or local ordinance electrical permits and inspections before beginning construction.

B. Pay electric, telephone, and cable TV fees or reimbursable construction costs to the utilities in a timely manner so as not to delay construction.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION

A. General Product Requirements: Provide products that comply with the Contract Documents that are undamaged and unused at the time of installation.

1. Provide products complete with all accessories, trim, finish, safety guards and other devices and details needed for a complete installation and for the intended use and effect.

2. Standard Products: Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.

B. Product Selection Procedures: Product selection is governed by the Contract Documents and governing regulations, not by previous Project experience. Procedures governing product selection include the following:

1. Proprietary Specification Requirements: Where only a single product or manufacturer is named, provide the product indicated. No substitutions will be permitted.

2. Compliance with Standards, Codes and Regulations: Where the Specifications only require compliance with an imposed code, standard or regulation, select a product that complies with the standards, codes or regulations specified.

3. Visual Matching: Where Specifications require matching an established Sample, the Architect's decision will be final on whether a proposed product matches satisfactorily.

a. Where no product available within the specified category matches satisfactorily and also complies with other specified requirements, comply with provisions of the Contract Documents concerning "substitutions" for selection of a matching product in another product category, or for noncompliance with specified requirements.

4. Visual Selection: Where specified product requirements include the phrase "...as selected from manufacturer's standard colors, patterns, textures..." or a similar phrase, select a product and manufacturer that complies with other specified requirements. The Architect will select the color, pattern and texture from the product line selected.

2.2 SUBSTITUTIONS

- A. Conditions: A Contractor's substitution request will be received and considered by the Architect/Engineer when one or more of the following conditions are satisfied, as determined by the Architect/Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.**
1. Extensive revisions to Contract Documents are not required.
 2. Proposed changes are in keeping with the general intent of Contract Documents.
 3. The request is timely, fully documented and properly submitted. All substitution requests shall be received a minimum of two weeks prior to the bid opening.
 4. The request is directly related to an "or equal" clause or similar language in the Contract Documents.
 5. The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly, or an unwillingness to pay special freight or factory charges to reduce the time of manufacturing.
 6. The specified product or method of construction cannot receive necessary approval by a governing authority, and the requested substitution can be approved.
 7. A substantial advantage is offered the Owner, in terms of cost, time, or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Architect for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.
 8. The specified product or method of construction cannot be provided in a manner that is compatible with other materials, and where the Contractor certifies that the substitution will overcome the incompatibility.
 9. The specified product or method of construction cannot be coordinated with other materials, and where the Contractor certifies that the proposed substitution can be coordinated.
 10. The specified product or method of construction cannot provide a warranty required by the Contract Documents and where the Contractor certifies that the proposed substitution provide the required warranty.
 11. Where a proposed substitution involves more than one Contractor, each Contractor shall cooperate with the other Contractors involved to coordinate the Work, provide uniformity and consistency, and to assure compatibility of products.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION PROVISIONS

- A. Inspection of Conditions: Require the Installer of each major component to inspect both the substrate and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.**
- B. Manufacturer's Instructions: Comply with manufacturer's installation instructions and recommendations, to the extent that those instructions and recommendations are more explicit or stringent than requirements contained in Contract Documents.**
- C. Inspect materials or equipment immediately upon delivery and again prior to installation. Reject damaged or defective items. Do not repair damaged or defective items. Replace all damaged or defective items with new items.**
- D. Provide attachment and connection devices and methods necessary for securing Work. Secure Work true to line and level. Allow for expansion and building movement.**
- E. Visual Effects: Provide uniform joint widths in exposed Work. Arrange joints in exposed Work to obtain the best visual effect. Refer questionable choices to the Architect for final decision.**

- F. Recheck measurements and dimensions, before starting each installation.
- F. Install each component during weather conditions and Project status that will ensure the best possible results. Isolate each part of the completed construction from incompatible material as necessary to prevent deterioration.
- G. Coordinate temporary enclosures with required inspections and tests, to minimize the necessity of uncovering completed construction for that purpose.
- H. Mounting Heights: Where mounting heights are not indicated, install individual components at standard mounting heights recognized within the industry for the particular application indicated. Refer questionable mounting height decisions to the Architect for final decision.
- I. Internet Access: The Owner will NOT provide internet access on site for use by the AV installer during the installation.

3.2 CLEANING AND PROTECTION

- A. During handling and installation, clean and protect construction in progress and adjoining materials in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- B. Clean and maintain completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- C. Limiting Exposures: Supervise construction activities to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.3 PROJECT CLOSEOUT

- A. General: Comply with final punch list requirements.
- B. Operating and Maintenance Instructions: Arrange for each installer of equipment that requires regular maintenance to meet with the Owner's personnel to provide instruction in proper operation and maintenance. If installers are not experienced in procedures, provide instruction by manufacturer's representatives. Include a detailed review of the following items:
 - 1. Maintenance manuals.
 - 2. Record documents.
 - 3. Spare parts and materials.
 - 4. Tools.
 - 5. Identification systems.
 - 6. Control sequences.
 - 7. Hazards.
 - 8. Cleaning.
 - 9. Warranties and bonds.
 - 10. Maintenance agreements and similar continuing commitments.
- C. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.
 - 1. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.

- a. Remove labels that are not permanent labels.
- b. Clean transparent materials. Replace chipped or broken lenses and other damaged transparent materials.
- c. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition.
- d. Wipe surfaces of all Technology equipment clean.

D. System Start Up: Provide a senior technician who is proficient with all specified systems, who is intimately familiar with this project, and who personally participated in the planning and installation of this project. Assign technician to be on site during the first day of use by the Owner after construction is complete and all punch list items have been resolved. Technician will work closely with the Owner's technical support personnel, and will assist the Owner with any and all needs relative to the newly installed audio, video and control systems. Tasks will include, but not be limited to, reports of technical problems, correction of malfunctioning systems, clarification of operating instructions, and assistance with help desk calls. Include all associated costs in the base bid for this project.

E. Occupancy Adjustments: When requested by the Owner or the A/V Consultant within one year of date of substantial completion, provide on-site assistance for any reason related to the audio, video and control system. Possible reasons for occupancy adjustments may include, but not be limited to changing levels; making minor programming changes to digital signal processors, control systems, or other similar devices; calibration of projectors; changing transformer taps, or adjusting controls to suit actual occupied conditions. Include three occupancy adjustment trips to the site in the base bid for this project.

A.
END OF SECTION 27 4100

SECTION 27 4101

BASIC TECHNOLOGY SYSTEMS REQUIREMENTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions apply to this section.

1.2 SUMMARY

- A. This Section includes general administrative and procedural requirements for technology systems installations. The following administrative and procedural requirements are included in this Section:
 - 1. Submittals
 - 2. Coordination drawings
 - 3. Record documents
 - 4. Maintenance manuals
 - 5. Rough-ins
 - 6. Technology systems installations
 - 7. Cutting and patching
- B. Related Sections: All Division 27 sections contain requirements that relate to this section.
- C. Related Sections: Several Division 26 sections contain requirements that relate to this section.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer licensed for the work to be performed in the state and/or locality in which the work is performed. Licenses shall be carried at all times and shown upon request. Installer shall be a duly authorized representative of the manufacturer of technology systems equipment. Refer to sections 27 41 13, 27 41 14, and 27 41 15 for definitions of an experienced installer.

1.4 SUBMITTALS

- A. Provide eight copies of submittals. One copy will be retained by the technology systems Consulting Engineer.
 - 1. Shop Drawings: 1 additional black-line prints.
 - 2. Product Data: 1 additional copy of each item.
- B. Additional copies may be required by individual sections of these Specifications.
- C. List of AV equipment to be connected to the owner's data network. (See "IP Address Assignments" this section).

1.5 COORDINATION DRAWINGS

- A. Prepare coordination drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of technology systems equipment and materials in relationship with other

systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Where deviations from contract documents are proposed, submit proposed changes prior to proceeding with the work.

1.6 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT." Maintain during the course of construction a blue-line set of contract drawings and shop drawings in clean, undamaged condition, with mark-up of actual installations which vary substantially from the work originally shown. Mark with red erasable pencil. Mark-up new information which is recognized to be of importance to Owner, but was for some reason not shown the drawings. Give particular attention to concealed work, which would be difficult to measure and record at a later date. In addition to the requirements specified in Division 1, indicate installed conditions for:

1. Redline changes or information from construction set
2. Cable pathways, size and location
3. Equipment locations
4. Approved substitutions, Contract Modifications, and actual equipment and materials installed

1.7 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSEOUT"; however, in no case shall fewer than 3 maintenance manuals in three ring binders be provided. In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions charts and schedules.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 ROUGH-IN

A. Since the drawings of floor and ceiling installations are made at a small scale, outlets, devices, equipment, etc., are indicated only in their approximate location. Do not scale technology systems drawings. Refer to the architectural and mechanical drawings and dimensions. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

- B. Refer to equipment specifications in Divisions for rough-in requirements.

3.2 TECHNOLOGY SYSTEMS INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of technology systems, materials, and equipment. Comply with the following requirements:
1. Coordinate technology systems, equipment, and materials installation with other building components.
 2. Verify all dimensions by field measurements.
 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for technology systems installations.
 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 5. Sequence, coordinate, and integrate installations of technology systems materials and equipment for efficient flow of the Work. Give particular attention to large equipment.
 6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 7. Coordinate and obtain written approval from Owner's representative at least 7 days in advance for technology systems service interruption.
 8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
 9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
 10. Install technology systems equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
 11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
- B. IP Address Assignments: The Owner's Information Technology Department will assign an IP address space for all AV equipment requiring an Ethernet network connection to be provided as part of this project in compliance with the following:
1. All AV equipment will connect directly to an isolated VLAN on the Owner's data network. The AV equipment does not need to be VLAN aware.
 2. Any modifications with respect to the mandated IP Address Assignment Procedure must be approved during the submittal process.
 3. IP Address Assignment Procedures:
 - a. The AV Contractor shall provide a list of AV equipment to be connected to the Owner's data network at least three (3) working days prior to installation. The AV equipment list shall be provided to the Owner in a spreadsheet or comma-delimited file format. The equipment information shall include the following:
 - 1) Manufacturer
 - 2) Model Number
 - 3) Serial Number
 - 4) Media Access Control (MAC) address
 - 5) Project room number where the equipment is to be installed
 - b. The Owner's Information Technology Department will register the above provided AV equipment and MAC addresses for use on the Owner's network, and assign an IP address to each piece of equipment.
 - c. The Owner will provide the equipment list file back to the AV contractor with IP address assignments within three (3) working days of receipt of the equipment list.

- d. The AV Contractor shall submit an updated equipment list with any equipment changes or configuration modifications that occur during the course of the project
4. Network Connection.
 - a. The AV contractor shall provide a labeled data patch cable per the project specifications, and connect the AV equipment directly to the data outlet provided at each AV equipment location.

3.3 CUTTING AND PATCHING

- A. General: Perform cutting and patching where required to complete the technology systems installation. Perform cutting and patching in compliance with the following requirements:
 1. Perform cutting, fitting, and patching of technology systems equipment and materials required to:
 - a. Uncover Work to provide for installation of ill-timed Work.
 - b. Remove and replace defective Work.
 - c. Remove and replace Work not conforming to requirements of the Contract Documents.
 - d. Remove samples of installed Work as specified for testing.
 - e. Install equipment and materials in existing structures.
 - f. Upon written instructions from the Architect, uncover and restore Work to provide for Architect observation of concealed Work.
 2. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
 3. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
 4. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
 5. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.
 - a. Refer to Division 1 Section "DEFINITIONS AND STANDARDS" for definition of experienced "Installer."
 6. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.
 - a. Refer to Division 1 Section "DEFINITIONS AND STANDARDS" for definition of experienced "Installer."

3.4 FINAL PUNCH LIST

- A. General: In addition to the requirements of Division 1 for substantial completion, include the following:
 1. Prerequisite personnel for technology systems final punch list:
 - a. Technology systems project engineer must be present.
 - b. Technology systems installer job foreman must be present.
 - c. Additional personnel may be required by other sections of this specification.
 2. Other prerequisites for technology systems final punch list:
 - a. List of incomplete items, value of incompleteness, and reasons for being incomplete.
 - b. Submit record drawings, record specifications, maintenance manuals, warranties, and summary test report.

- c. Deliver tools, spare parts, extra stocks of materials, and similar physical items to Owner. Provide delivery receipt signed by Owner's representative.
 - d. Complete start-up testing of systems and instructions of Owner's operating/maintenance personnel.
 - e. Clear access shall be provided to all devices and equipment.
 - f. Installer shall have pad and pencil to list all deficient items noted.
 - g. All corrections and adjustments shall be done after the inspection, not during. These items will appear on the final punch list.
 - h. Required keys for panels and doors.
3. Comply with other prerequisites as specified in other sections of the specification.

END OF SECTION 27 4101

SECTION 27 4102

BASIC TECHNOLOGY SYSTEMS MATERIALS AND METHODS

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes limited scope general construction materials and methods for application with technology systems installations as follows:
 - 1. Selective demolition including:
 - a. Nondestructive removal of materials and equipment for reuse or salvage as indicated.
 - b. Dismantling technology systems materials and equipment made obsolete by these installations.
 - 2. Miscellaneous metals for support of technology systems materials and equipment.
 - 3. Wood grounds, nailers, blocking, fasteners, and anchorage for support of technology systems materials and equipment.
 - 4. Joint sealers for sealing around technology systems materials and equipment; and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
 - 5. Access panels and doors in walls, ceilings, and floors for access to technology systems materials and equipment.
 - 6. Painting of technology systems materials and equipment.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements specified in Division 27 Section "Basic technology systems Requirements" apply to this Section.

1.3 SUBMITTALS

- A. Submit in accordance with Sections 013310, Submittal Procedures, and 013323, Shop Drawings, Product Data and Samples.
- B. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- C. Product data for the following products:
 - 1. Joint sealers.
- D. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for technology systems materials and equipment.
- E. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of technology systems service, and details for dust and noise control.
 - 1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 1 Section "Summary of Work."
 - 2. Submit shop drawings indicating technology systems modifications to existing systems.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer for the installation. Refer to sections 27 41 13, 27 41 14 and 27 41 15 for definitions of an experienced installer.
- B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide UL listed assemblies to maintain specified rating where technology systems or technology systems components penetrate rated assemblies. Refer to manufacturers listed in the UL "Building Materials Directory" for rating shown. Products include, but are not limited to:
 - 1. Access doors
 - 2. Conduit penetrations
 - 3. Communication outlets

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver joint sealer materials in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle joint sealer materials in compliance with the manufacturers' recommendations to prevent their deterioration and damage.

1.6 PROJECT CONDITIONS

- A. Conditions Affecting Selective Demolition: The following project conditions apply:
 - 1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 - 2. Locate, identify, and protect technology systems services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

1.7 SEQUENCE AND SCHEDULING

- A. Coordinate the shut-off and disconnection of technology systems service with the Owner.
- B. Notify the Architect at least 5 days prior to commencing demolition operations.
- C. Perform demolition in phases as indicated.

1.8 PAINTING

- A. Paint exposed surfaces whether or not colors are designated in "schedules," except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the Architect will select from standard colors or finishes available.
 - 1. Painting includes field painting hangers, exposed steel and iron work, and primed metal surfaces of technology systems equipment.

PART 2 - PRODUCTS

2.1 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout, recommended for interior and exterior applications.
- F. Fasteners: Zinc-coated, type, grade, and class as required.

2.2 MISCELLANEOUS LUMBER

- A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.
- B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 3/4 inches and painted with suitable fire rated paint material where required.

2.3 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Architect from manufacturer's standard colors.
- C. Fire-Resistant Joint Sealers: Two-part, foamed-in-place, silicone sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.
- D. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bar-Co., Inc.
 - 2. J.L. Industries.
 - 3. Karp Associates, Inc.
 - 4. Milcor Div. Inryco, Inc.
 - 5. Nystrom, Inc.

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 installation and application of joint sealers and access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION FOR JOINT SEALERS

- A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
- B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.3 SELECTIVE DEMOLITION

- A. All obsolete technology systems equipment shall remain the property of the owner.
- B. General: Demolish, remove, de-mount, and disconnect abandoned technology systems materials. Coordinate with other work, including technology systems wiring work, as necessary to interface installation of existing equipment with other work. New technology systems equipment and apparatus shall be coordinated and connected into the existing systems. Relocate existing technology systems devices, conduit and/or equipment that for any reason obstructs construction. All technology systems equipment and apparatus in the building not remodeled shall be connected and remain in working condition. Include any equipment having technology systems connections that requires disconnecting and re-connection at the same or another location throughout the course of construction.
- C. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor technology systems materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.5 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor technology systems materials and equipment.
- B. Select fastener sizes that will not 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 members.
- C. Attach to substrates as required to support applied loads.
- D. Install 4' X' X 3/4" plywood terminal boards in enclosures or mounted on walls where indicated in the drawings.

3.6 SEISMIC BRACING

- A. General: Provide vibration isolators, flexible connections, rigid steel frames, concrete inertia bases, anchors, inserts, hangers, and attachments, seismic bracing and snubbers as required for seismic control and prevention of the transmission of vibration for both isolated and non-isolated systems. Comply with seismic requirements for the proper seismic zone for all support systems.
 - 1. Vibration isolated equipment shall be mounted on rigid steel frames or concrete bases. Each spring mounted base shall have a minimum of four all directional seismic snubbers that are double acting and located as close to the vibration isolators as possible to facilitate attachment

- both to the base and the structure. The snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications.
2. Non-isolated equipment shall be installed according to UBC Sec. 2312 (g); Cp Factor Table 23J, I Factor Table 23K.4.C In addition, the vertical forces restraint requirements shall be computed as the $\frac{1}{2}$ the value of the horizontal forces.

3.7 APPLICATION OF JOINT SEALERS

- A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 2. Comply with recommendations of ASTM C 790 for use of acrylic- emulsion joint sealants.
- B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
- C. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around technology systems services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

END OF SECTION 27 4102

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

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. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Device guards.
7. Firefighters' two-way telephone communication service.
8. Magnetic door holders.
9. Remote annunciator.
10. Graphic annunciator.
11. Addressable interface device.
12. Digital alarm communicator transmitter.
13. Network communications.

- B. Related Requirements:

1. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for cables and conductors for fire-alarm systems.

1.3 DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. FACP: Fire Alarm Control Panel.
- C. HLI: High Level Interface.
- D. NICET: National Institute for Certification in Engineering Technologies.
- E. PC: Personal computer.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 2. Include rated capacities, operating characteristics, and electrical characteristics.
- B. Shop Drawings: For fire-alarm system.
1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 2. Include plans, elevations, sections, details, and attachments to other work.
 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
 4. Detail assembly and support requirements.
 5. Include voltage drop calculations for notification-appliance circuits.
 6. Include battery-size calculations.
 7. Include input/output matrix.
 8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
 9. Include performance parameters and installation details for each detector.
 10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
 12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Show field wiring required for HVAC unit shutdown on alarm.
 - c. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' control system.
 - d. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
 - e. Locate detectors according to manufacturer's written recommendations.
 - f. Show air-sampling detector pipe routing.
 13. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
 14. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.
- C. General Submittal Requirements:
1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
 2. Shop Drawings shall be prepared by persons with the following qualifications:

- a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level III minimum.
 - c. Licensed or certified by authorities having jurisdiction.
- D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
 2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
 3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 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.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:
 - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.

- d. Riser diagram.
- e. Device addresses.
- f.**
- g. Record copy of site-specific software.
- h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
- i. Manufacturer's required maintenance related to system warranty requirements.
- j. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

- 1. Software operating and upgrade manuals.
- 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
- 3. Device address list.
- 4. Printout of software application and graphic screens.

1.7 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. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
 - 2. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
 - 3. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
 - 4. Keys and Tools: One extra set for access to locked or tamperproofed components.
 - 5. Audible and Visual Notification Appliances: One of each type installed.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.
- C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

1.9 PROJECT CONDITIONS

- A. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
 - 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
- B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice/strobe evacuation.
- C. Automatic sensitivity control of certain smoke detectors.
- D. All components provided shall be listed for use with the selected system.
- E. 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 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
 - 1. Manual stations.
 - 2. Heat detectors.
 - 3. Smoke detectors.
 - 4. Duct smoke detectors.
 - 5. Automatic sprinkler system water flow.
 - 6. Preaction system.
 - 7. Fire-extinguishing system operation.
 - 8. Fire standpipe system.
 - 9. Dry system pressure flow switch.
- B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances, including voice evacuation notices.
2. Identify alarm and specific initiating device at fire-alarm control unit, connected network control panels, and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Activate smoke-control system (smoke management) at firefighters' smoke-control system panel.
9. Activate stairwell and elevator-shaft pressurization systems.
10. Close smoke dampers in air ducts of designated air-conditioning duct systems.
11. Activate preaction system.
12. Recall elevators to primary or alternate recall floors.
13. Activate elevator power shunt trip, after return of elevators to designated floors.
14. Activate emergency lighting control.
15. Activate emergency shutoffs for gas and fuel supplies.
16. Record events in the system memory.
17. Indicate device in alarm on the graphic annunciator.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. High- or low-air-pressure switch of a dry-pipe or preaction sprinkler system.
3. Alert and Action signals of air-sampling detector system.
4. Elevator shunt-trip supervision.
5. Independent fire-detection and -suppression systems.
6. User disabling of zones or individual devices.
7. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Voice signal amplifier failure.
11. Hose cabinet door open.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit, connected network control panels and remote annunciators.

3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
4. Transmit system status to building management system.
5. Display system status on graphic annunciator.

2.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. 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 and the unit will be fully operational after the seismic event."

2.4 FIRE-ALARM CONTROL UNIT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Fire-Lite Alarms, Inc.; a Honeywell International company.
 2. Gamewell - FCI by Honeywell.
 3. GE UTC Fire & Security; A United Technologies Company.
 4. Mircom Technologies, Ltd.
 5. Notifier.
 6. Siemens Industry, Inc.; Fire Safety Division.
 7. Silent Knight.
 8. SimplexGrinnell LP.
- B. General Requirements for Fire-Alarm Control Unit:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
 - a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 - c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
 - d. The FACP shall be listed for connection to a central-station signaling system service.
 - e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
 3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
- C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
- D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
1. Pathway Class Designations: NFPA 72, Class A.
 2. Pathway Survivability: Level 1.
 3. Install no more than 50 addressable devices on each signaling-line circuit.
 4. Serial Interfaces:
 - a. One dedicated RS 485 port for central-station operation using point ID DACT.
 - b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
 - c. One RS 232 port for PC configuration.
 - d. One RS 232 port for voice evacuation interface.
- E. Stairwell and Elevator Shaft Pressurization: Provide an output signal using an addressable relay to start the stairwell and elevator shaft pressurization system. Signal shall remain on until alarm conditions are cleared and fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands.
1. Pressurization starts when any alarm is received at fire-alarm control unit.
 2. Alarm signals from smoke detectors at pressurization air supplies have a higher priority than other alarm signals that start the system.
- F. Smoke-Alarm Verification:
1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
 3. Record events by the system printer.
 4. Sound general alarm if the alarm is verified.
 5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
- G. Notification-Appliance Circuit:
1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.

2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

H. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
 - a. Elevator lobby detectors except the lobby detector on the designated floor.
 - b. Smoke detector in elevator machine room.
 - c. Smoke detectors in elevator hoistway.
2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
 - a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

I. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

J. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

K. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

L. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided in a separate cabinet located in adjacent to the fire alarm control panel.

1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.
 - a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
 - b. Programmable tone and message sequence selection.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear."

- d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.
 2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
 3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
- M. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- N. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
1. Batteries: Sealed, valve-regulated, recombinant lead acid.
- O. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.5 PREACTION SYSTEM

- A. Initiate Presignal Alarm: This function shall cause an audible and visual alarm and indication to be provided at the FACP. Activation of an initiation device connected as part of a preaction system shall be annunciated at the FACP only, without activation of the general evacuation alarm.

2.6 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 2. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 3. Station Reset: Key- or wrench-operated switch.
 4. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

5. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.7 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
6. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
 - b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).
 - c. Multiple levels of detection sensitivity for each sensor.
 - d. Sensitivity levels based on time of day.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

C. Ionization Smoke Detector:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

- a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
- D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
 3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
 4. Each sensor shall have multiple levels of detection sensitivity.
 5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.8 PROJECTED BEAM SMOKE DETECTORS

- A. Projected Beam Light Source and Receiver: Designed to accommodate small angular movements and continue to operate and not cause nuisance alarms.
- B. Detector Address: Accessible from fire-alarm control unit and able to identify the detector's location within the system and its sensitivity setting.
- C. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 1. Primary status.
 2. Device type.
 3. Present average value.
 4. Present sensitivity selected.
 5. Sensor range (normal, dirty, etc.).

2.9 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
 1. Temperature sensors shall test for and communicate the sensitivity range of the device.

- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
 - 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.10 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.
- B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.
- D. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
 - 1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 - 2. Mounting: Wall mounted unless otherwise indicated.
 - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - 4. Flashing shall be in a temporal pattern, synchronized with other units.
 - 5. Strobe Leads: Factory connected to screw terminals.
 - 6. Mounting Faceplate: Factory finished, red white – as selected by Architect.
- E. Voice/Tone Notification Appliances:
 - 1. Comply with UL 1480.
 - 2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
 - 3. High-Range Units: Rated 2 to 15 W.
 - 4. Low-Range Units: Rated 1 to 2 W.
 - 5. Mounting: semirecessed.

6. Matching Transformers: Tap range matched to acoustical environment of speaker location.

F. Exit Marking Audible Notification Appliance:

1. Exit marking audible notification appliances shall meet the audibility requirements in NFPA 72.
2. Provide exit marking audible notification appliances at the entrance to all building exits.
3. Provide exit marking audible notification appliances at the entrance to areas of refuge with audible signals distinct from those used for building exit marking.

2.11 FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SERVICE

A. Dedicated, two-way, supervised, telephone voice communication links between fire-alarm control unit and remote firefighters' telephone stations. Supervised telephone lines shall be connected to talk circuits by controls in a control module. Provide the following:

1. Common-talk type for firefighter use only.
2. Selective-talk type for use by firefighters and fire wardens.
3. Controls to disconnect phones from talk circuits if too many phones are in use simultaneously. An indicator lamp shall flash if a phone is disconnected from the talk circuits.
4. Addressable firefighters' phone modules to monitor and control a loop of firefighter phones. Module shall be capable of differentiating between normal, off-hook, and trouble conditions.
5. Audible Pulse and Tone Generator, and High-Intensity Lamp: When a remote telephone is taken off the hook, it causes an audible signal to sound and a high-intensity lamp to flash at the fire-alarm control unit.
6. Selector panel controls to provide for simultaneous operation of up to six telephones in selected zones. Indicate ground faults and open or shorted telephone lines on the panel front by individual LEDs.
7. Display: digital to indicate location of caller.
8. Remote Telephone Cabinet: Flush- or surface-mounted cabinet as indicated, factory-standard red finish, with handset.
 - a. Install one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating "Fire Emergency Phone."
 - b. With "break-glass" type door access lock.
9. Remote Telephone Jack Stations: Single-gang, stainless-steel-plate mounted plug, engraved "Fire Emergency Phone."
10. Handsets: push-to-talk-type sets with noise-canceling microphone stored in a cabinet adjacent to fire-alarm control unit.

2.12 FIREFIGHTERS' SMOKE-CONTROL SYSTEM

A. Initiate Smoke-Management Sequence of Operation:

1. Comply with sequence of operation as described in Section 230993.11 "Sequence of Operations for HVAC DDC."
2. Fire-alarm system shall provide all interfaces and control points required to properly activate smoke-management systems.
3. First fire-alarm system initiating device to go into alarm condition shall activate the smoke-control functions.
4. Subsequent devices going into alarm condition shall have no effect on the smoke-control mode.

B. Addressable Relay Modules:

1. Provide address-setting means on the module. Store an internal identifying code for control panel use to identify the module type.
2. Allow the control panel to switch the relay contacts on command.
3. Have a minimum of two normally open and two normally closed contacts available for field wiring.
4. Listed for controlling HVAC fan motor controllers.

2.13 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 120-V ac.

B. Material and Finish: Match door hardware.

2.14 GRAPHIC ANNUNCIATOR

A. Graphic Annunciator Panel: Mounted in an aluminum frame with nonglare, minimum 3/16-inch- (4.76-mm-) thick, clear acrylic cover over graphic representation of the facility. Detector locations shall be represented by red LED lamps. Normal system operation shall be indicated by a lighted, green LED. Trouble and supervisory alarms shall be represented by an amber LED.

1. Comply with UL 864.
2. Operating voltage shall be 24-V dc provided by a local 24-V power supply provided with the annunciator.
3. Include built-in voltage regulation, reverse polarity protection, RS 232/422 serial communications, and a lamp test switch.
4. Surface mounted in a NEMA 250, Type 1 cabinet, with key lock and no exposed screws or hinges.
5. Graphic representation of the facility shall be a CAD drawing and each detector shall be represented by an LED in its actual location. CAD drawing shall be at 1/8-inch per foot ((10-mm per meter)) scale or larger.
6. The LED representing a detector shall flash two times per second while detector is an alarm.

- B. Graphic Annunciator Workstation: PC-based, with fire-alarm annunciator software with historical logging, report generation, and a graphic interface showing all alarm points in the system. PC with operating system software, minimum 100GB hard drive, 32 inch digital display monitor, with wireless keyboard and mouse.

2.15 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
 - 1. Mounting: Flush cabinet, NEMA 250, Type 1.
- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.16 ADDRESSABLE INTERFACE DEVICE

- A. General:
 - 1. Include address-setting means on the module.
 - 2. Store an internal identifying code for control panel use to identify the module type.
 - 3. Listed for controlling HVAC fan motor controllers.
- B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- C. Integral Relay: Capable of providing a direct signal for control functions indicated.
 - 1. Allow the control panel to switch the relay contacts on command.
 - 2. Have a minimum of two normally open and two normally closed contacts available for field wiring.
- D. Control Module:
 - 1. Operate notification devices.
 - 2. Operate functions in external systems as indicated.

2.17 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the

remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1. Verification that both telephone lines are available.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
 - 1. Address of the alarm-initiating device.
 - 2. Address of the supervisory signal.
 - 3. Address of the trouble-initiating device.
 - 4. Loss of ac supply.
 - 5. Loss of power.
 - 6. Low battery.
 - 7. Abnormal test signal.
 - 8. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.18 NETWORK COMMUNICATIONS

- A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements and requirements in NFPA 72.

2.19 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
 - 1. Factory fabricated and furnished by device manufacturer.
 - 2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Install wall-mounted equipment, with tops of cabinets not more than **78 inches (1980 mm)** above the finished floor.
 - 1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in the normal path of egress within **60 inches (1520 mm)** of the exit doorway.
 - 2. Mount manual fire-alarm box on a background of a contrasting color.
 - 3. The operable part of manual fire-alarm box shall be between **42 inches (1060 mm)** and **48 inches (1220 mm)** above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- D. Smoke- or Heat-Detector Spacing:
 - 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 - 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 - 3. Smooth ceiling spacing shall not exceed **30 feet (9 m)**.

4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
 5. HVAC: Locate detectors not closer than **36 inches (910 mm)** from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than **12 inches (300 mm)** from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
- E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than **36 inches (9100 mm)** long shall be supported at both ends.
1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
- G. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.
- H. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- I. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- J. Audible Alarm-Indicating Devices: Install not less than **6 inches (150 mm)** below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- K. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least **6 inches (150 mm)** below the ceiling. Install all devices at the same height unless otherwise indicated.
- L. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.3 PATHWAYS

- A. All wiring and cabling shall be installed in EMT.
- B. Exposed EMT shall be painted red enamel.

3.4 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than **36 inches (910 mm)** from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
1. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
 2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
 3. Smoke dampers in air ducts of designated HVAC duct systems.
 4. Magnetically held-open doors.
 5. Electronically locked doors and access gates.
 6. Alarm-initiating connection to elevator recall system and components.
 7. Alarm-initiating connection to activate emergency lighting control.
 8. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
 9. Supervisory connections at valve supervisory switches.
 10. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
 11. Supervisory connections at elevator shunt-trip breaker.
 12. Data communication circuits for connection to building management system.
 13. Data communication circuits for connection to mass notification system.
 14. Supervisory connections at fire-extinguisher locations.
 15. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
 16. Supervisory connections at fire-pump engine control panel.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.6 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction. Notify Architect/Engineer 7 days in advance.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

- C. Perform tests and inspections.
- D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283111